412/7274 #3

LIBRARY COMPANY

OF

PHILADELPHIA.

RIDGWAY BRANCH.

PRESENTED BY

COMMUNITER BONA PROFUNDERE DEORUM EST.

Notes

written by

Benj. a Mrs Rath

of Calcareous Earths

Many things produce their Effects. I
shall give upon my own conjecture upon
the Subject tho' the cause of y^e Earthly
of Ground are not properly ascertained.
Clays are probably the Bases of all
soils, but are unfitt by themselves to
support Vegitables, without y^e Media-
tion of some other Bodies to render
them properly diffusable in water. Suita-
ble Bodies must suited to this pur-
pose. for if you expose a portion of stiff
clay to the falling Rains which are
generally replete w^th: you find in a little time it
time becomes readily diffusable in water,

of the Fertilization of Ground.

Clayey in its texture - & an extremely improper matrix for the nourishment of Plants. It supports Vegetation Earths act Only by promoting Putrefaction & purchase in their calcined state produce some Change in y/ Structure of the Clay since it then becomes a saline Body.

Calcarious Earths are also employed when calcined as Cements in Building. The Workmen find that y/ Cements Ch. = tained from Chalk & Limestone are endowed w: different Qualities, tho' on w: this Variety depends we have not yet determined. The Earth ought to be ta= =ken

for from any foreign matter, espec:
other Earths &c: frequently dissolvd
ves of the Lime by various
means as Vitrification &c.

The Caustic Calcarious Earth dissol-
=ved in water becomes "Lime water" the
so much celebrated Medicine for dissolving
Calculi of the Bladder & Kidneys. It is
also called Ol: Calcis, & the Liquid Shell.

In arts the Lime water is employed
for the purification of Sugars, on w:ch
acts by Absorbing the Acid of y^e Saccharine
Juice, w:ch Attenuates & prevents the Grane-
=lation of the Sugar, & retains it in the

Of Calcareous Earths.

Lime of a Square 2nd. It unites w. 4 Oz of the Juice into a Paste which may be easily separated by washing.

By restoring the water & sulphuric air which the Quick lime loses in Calcination, it becomes a Crystallized Salt or the common Cement for Building It will appear evident that Slaking must be in Situ. before Calcination to have place firmly, or in other words before the Quick-Lime becomes mild. Lest on ye Brad that it forms a friable Mass extremely liable to Fissures when dry, we must endeavour to obviate the Inconvenience by the Addition of some

Calcarious Earths

Calcarious Body which is most commonly
found. The Effects of which I shall illus-
= trate in the following manner. If a
Cubic Inch of wet Clay is exposed to the
Heat or Air, it will contract in drying
$\frac{1}{10}$ of an Inch, and form a Fissure equal
to the Space contracted: but if 100 Cubic
Inches of Sand be added, & the Clay equally
diffused thro it each portion of Clay will
be a hundred times less than before, and
will consequently form cracks proporti-
=onably less. —

Gypsum or Selenites is a Crystalized
Salt composed of Vit: Acid & Calcar: Earth.

# of Calcarious Earths

The chief use is to take of the Impressions
of Moulds. for this purpose its water is
extracted when like other Sulphat salts it
falls to powder. But when y^e^ water is
restored it again concretes or curdles,
so that the nicest lines of a mould are
impressed upon it. The preparation of
Gypsum in large works must be per-
formed in Furnaces. but for private
practise we may employ an Iron pot.
The Gypsum must be put into the
Pot in Fragments about as large as
Hens: Eggs. Soon after the Heat is abated
it begins to boil: when y^e^ boiling ceases

Of Calcarious Earth

we must remove it from the Fire, be-
=cause the water of the Gypsum is then dissi-
=pated. And if the Fire is continued after-
=wards, a Decomposition of the Acid
in the place. The Figures usually made by
Gypsum are rough on the surface, but they
have lately found that by the addition of
Glue it will receive a polish like Marble,
and that by the addition of various Colours
it may be rendered very like Marble.

Of Crystalline Salts

These have been called by Authors Vi-
-trescent, from their transparent ap-
-pearance, tho very improperly, for they are
not vitrifiable when pure by any Degree of
Heat. They are hard enō to strike fire
from Steel — not acted upon by any mun-
-dane — and remarkably first incy:
Fire. M.r Cronstadt divides y.e Crys:
-talline into two kinds i: the truely Crystal
-line or Stone w.ch are not fusable in any
Heat 2.nd into such as are to be fused by
Common Fires. of this kind are his
Granata; such as their Fusibility seems
to depend upon y.e presence of an A: Alone,

Of Chrystallin Earths

I think they ought not to be considered as a distinct kind.

They are also divided into *sure* & *impure*. Of the latter sort are common Sands, and Spar of a particular sort which break into Fragments of an irregular Shape. Of the former are precious Stones and Crystals, whose Shapes are more or less angular, & such as break into Fragments alternately concave and convex, as Cornelians, Agates, Common Flints &c. — When joined w: Alkali they become fusible & form Glass. This ought to be done w: a proportion of

Of Crystalline Earths

Earth to Alk ∞ :: 3 : 2 . if a greater Propor-
=tion of Alkali be added it becomes Soluble
in Acids, and the Compound precipitated
is found to be an Absorb^t Earth.

Crystalline Earths are chiefly employed
in y^e Manufactory of Glass, w^ch Artis not
even now by any means Surfect. Your
will see an Acc^t of the Process in Commer.
I shall Only add that many People have
been mistaken in thinking y^e transparen.
-cy of Glass depended upon the use of cou=
=rless Substances: for a proper Adjust=
=ment of several Colours produc y^e most
Surfectly transparent Glass, & such as y^e
Workmen call a transparent Black. —

Of Argillaceous Earths.

There have been many Disputes concer-
=ning the Division of these Earths. Mr Pott
thinks that there is only one kind, &
that the various Species which have
been described, are nothing more than
evident Additions of other matters. we shall
however give the distinguishing properties
of Argillaceous Earths from many other
Calapses. They are never hard enough to strike
Fire from Steel; they are hardly dissolvable
Acids when dry: they readily absorb a large
proportion of water, & acquire with it great
Viscidity: if this mixture be exposed to the
Action of the Fire, it acquires a remar-
=kable hardness. on this acct: they are in

Of Argillaceous Earths

Great use Among the Potters, & Workers of various kinds of Porcelaine & Earthen Ware. —

Formerly we were ready to acknowledge, that the three kinds of Earths we have denied, were pure homogeneous Bodies, quite distinct in their natures & properties from each Other, & y: we even doubtfull whether as Some Authors have imagined, there was a homogenial Earth the Basis of all the rest: but Mr. Margraf by Some late Experiments has entirely removed that Doubt concerning a homogenial Earth. He tells us that Clay is acted upon by any

of Argillaceous Earths

And, especially the highly concentrated
Mineral Acids, with the assistance of
Heat. by such Application he discovers
Clay to be composed of a Corpuscline
& such an Absorbent Earth he enters
into the Composition of Alum. in the
Decomposition of Clay by the Vitriolic
Acid and the consequent Formation of
Alum I shall observe the following
Circumstance. That the Alum can't
be made by the Addition of Vitriolic
Acid & Earth without an Addition of Alk:
occasions
= Kali, w: tho it ~~contains~~ some precipi:
= tation gives rise to the production of savory
firm white crystalized Alum. —

of Argillaceous Earths

with Respect to a primogenial Earth.

we shall observe, that Clay does not seem to be such, since it is separable into the Crystalline & Absorbent. it may therefore be a subject of Enquiry whether Absorbent & Crystalline Earths are not Clays compound by some means or other? - Margraaf informs us of the following curious Fact, that water by Filtration & Evaporation is converted into an Earth composed of Crystallized Absorbents. & is perhaps a pure Clay. Margraaf says also that by repeated Distillations the Sediment of the Water becomes

greater. Clay w: a proper Addition of
Sand & Calcarious Sub: is extremely proper
for making Crucibles. —

of water

We shall now consider the 5th Class of Bodies, viz: Water, and refer you for a general Definition of it to the Objects of Chemistry. —

Some have supposed that water is chiefly supplied to the Earth by the precipitation of vapours exhaled in form of Rain on the Tops of Mountains, thro' which it filtrates breaking out in Fountains Brooks &c. Others suppose that the Atmosphere supplies the Surface of the Earth with a very small proportion of its water: but that waters continue to filtrate thro' the various Strata till they meet with Subterranean Lakes

of Water

drives them back in form of vapour &c:
rise till they are condensed by ye Mountains
as it were by Alembic &c. I am inclined to
think that ye former opinion is meant to
Truth, because in opening mines I am
informed that they are often interrupted
w: water, after descending below ye common
Level when rain waters penetrate.

From whatever source derived,
water in rising thro' numerous strata
is frequently impregnated w: various sub:
=stances.

When waters are so strongly impregnate

of Mineral Waters

as that we may refer their Smell or Taste to
their Bodies they are called Mineral, be-
=cause they are most commonly impreg-
=nated w: Min.l Substances. but when
Matters are of such a Quality or in such
Quantity as not to become Objects of
Our Smell or Taste the waters are called
Common. or such as we use for comm-
=merable purposes in Life. -
Independant of any foreign matters adhering
Water is Only Of One kind. tho' by no means
a pure Elementary Body. as some have
supposed. Since it is convertable into
Earth under a particular Modification. -

of Common Water

Common water as Obtained from Foun-
-tains is never entirely free from foreign
matters adhering more or less. When we
cannot distinguish the matters present
by the Taste or Smell we must then have
Recourse to Other Tests. When they are
impregnated th w: Earthy Matters we may
precipitate them by the Addition of Alkali;
-ies w: Acids by the Addition of Solution of
Silver in Nitrous Acid. but Sugar of Leadis
far the most perfect Test, since it will
cause Precipitation in water on w: ey:
Other Means produce no Change. The
Specific Gravity of water has been pro-
-ved by some as the most perfect mark

Common water

of its purity: but is erroneous since the
weight of water depends upon y^e^ Quantity
of Air present.

Mr. Margraff finds that Rain water receiv-
ed at a considerable Height in y^e^ Atmosphere
is equally pure w^th^ any that can be
obtained by repeated Distillations. it
is entirely free from all foreign matter, but
always retains a putrefactive substance
of Animal & Vegitable Origin.

Exactly similar to Rain water is y^e^
of Snow & Hail, only that the latter
contain much less Air, nor can we
discover the frigorific Salts w^ch^ Some

# of Common water

have that peculiar to them.

Dew are less pure than any waters of the Atmosphere. The water of Lakes are very pure, because they are generally supplied by Rains from the sides of Hills which have not filtrated thro many strata. They also are purified by the subsidence of Extraneous Matter; which probably forms the mud usually covering the firm Foundations of the Beds of Rivers & Lakes. That water is very speedily purified appears from the short time in which Rivers regain their purity after receiving the Discharge of Filth from

of Common water

~~Neighbours~~ populous Cities. We may
generally determine the purity of water
by the Distance at w^ch it issues from the
common Height of the adjacent Hills.

of Mineral Waters

Physicians & Chymists have frequently
attended to investigate y^e properties
of Mineral Waters, & the Causes of their
properties. But as most of them (for
want of Chemical Knowledge) either have
not known w^ch Bodies were truely fossile,
or w^ch of the fossile Substances could be
united w^th Water in a Separate or Compound
State, their Labours have proved in general
very unsuccessful. This is the Case of D^r Mutty

# of Mineral waters

of Dublin & his countryman D^r Lucas

Who w: much Arrogance has attempted

to correct his work. I shall give some

general Observations on this subject,

that you may be assisted not only in

discovering the Faults of others, but also

in correcting them by your own Inqui:

:ries.

Mineral Springs are generally divided

into the Acidulæ & Thermæ. The first name

is applied to all Springs sensibly impr:

:pregnated w: fossile matter of any kind,

the Impropriety of which is evident. The

Thermæ are distinguished on Acc^t: of the

of Mineral waters

that which they always discover. This
curious Phenomenon of the Heat of
Springs in the Effect of a Cause not easily
investigated. Some suppose y: in
running thro in[illegible] Pyrites they
become hot, or that their Heat is derived
from Subterranious Fires; but as many
waters have preserved a constant
Temperature of Heat for upwards of a
thousand years, it is improbable that
any Quantity of Pyrites sh? be so long
in flamed without producing a Change
either in the Direction or Temperature of y?
Water. Neither do we observe y: the

of Mineral waters

Effects of Subterraneous Fires are inva-
=riable, and always permanent as in
Volcanoes &c. Often imagine; the
Heat is produced by the Impregnation
of such Bodies as generate Heat in fer-
=tion. but we often find Plenty of such
Spirits, as not to be sensibly impreg-
=ted w: any Matter whatever. —

Such Waters only are called Mineral
Are impregnated w: Fossile Bodies; nor do
we find any Other except where y Strata
is continued along the Surface of y Ground
to some Distance. The Reason of this
seems to be y by a particular Oeconomy

Of Mineral Waters

Of Nature all Animal & Vegitable Sub-
-stances are converted into Fossile Substan-
-ces, After they are washed to a certain Depth
in the Earth. —

In Our Inquiries After such Fossile Bo-
-dies as impregnate Min: Waters, we shall
proceed in the usual Order beginning w: y: H & L
Saline.

Among y^e Acids none can be ranked
properly Fossile productions, except the
Vitriolic & Muriatic. The Vit: Acid do uni-
-versally dissolves or corrodes Fossile Sub:
-stances, y: we rarely find it separate in
Waters, except when Suddenly washed
out After a Decomposition from some

of Mineral Waters

of the Sulphuretted . the Pyrites of Coal Mines

often dilaquate when the air is admitted

and the Vitriolic Acid by ℥ij Muriate is formed

- times washed out by Ammonia w^h^ happens to

flow into their Cavities . And the Case

happens when we

Waters are seldom impregnated with

the Muriatic Acid in a separate State,

tho very frequently combined w^h^ Common

Salt, and fixt Ammoniac . M^r^ Proust

also informs us ℈ the latter is very

rarely found in Mineral Springs. —

# of Mineral waters.

Fixt Veg: Alk: is entirely excluded from the fossile Kingdom. If it has been at any time found in y^e^ Bowels of the Earth its Duration there is very short & it would soon probably have been con= =verted by the Acid of the Earth into a Fossile Alkali. hence we may con= =clude that Mineral waters are never impreg= =nated either w^th^ Veg: Alk: or its Compounds.

The Fossile Alk: is very frequently found in Mineral waters, both in a Separated & combounded State, but more frequently in the former than has been imagined. In the latter State it is found united with

of Mineral waters

To Epsom and into Bowman & Glauber's
Salt. The Spurious Salt of Glauber
combined of Oil & Magnesia differs
in Integrates Mineral water from the
genuine Neutral, and has therefore
been frequently mistaken for y^e true Sal
Glauber. Volatile Alkali never exists
separately or formally in y^e Epsom King-
: dom, but only: it may be produced
from Mineral waters in consequence of their
containing Hepar Sulphuris. which by
a Improperly conducted Distillation alway
gives out a Vol. Alkali.
We must take Care in reading Authors

of Mineral Waters

not to be misled by Terms. Thus Dr
Short says he found Nitre in almost
every mineral Spring: but he has
mistaken it for the Efflorescence of Sal Glau-
ber. Dr Hill has also mentioned his
Alcripsticum which is nothing more:
Fossile Alkali.

Oils both Animal & Vegitable are
exposed upon the Surface of the Earth, tho
we have never discovered them in the
Bowels thereof, & consequently not in
Mineral Waters. Naphtha, or Fossile
Oil frequently flows out on the Surface of
Springs, & is sometimes confined w: the

Of Mineral Waters

sin trinsically, as Sp: Central Lib: are combin
℔ss
w: distilled waters. Natron is sometim
combined w: ℔ss Sp: of Salt of Kali into a Soap
2
Sp: forms w: are called Saponaceous Wat
Sulphur alone admits of no union wit
water, and tho it is sometimes very
minutely diffused thro'in, yet when the
water is at Rest, the Sulphur subsides
it often unites w: ℔ss Sp: of Salt of Alk: into a
Hepar, & then becoming Soluble. it ge
= nerally impregnates Mineral Waters.
Odour
Taste & Colour of Hepar Sulph: is so very
diffusable, that from such Springs as
appear to be clear very strongly impr
= egnated

# of Mineral waters

we often cannot obtain one grain in
substance, and only discover its presence
by the Taste, Odour, and Change of Silver
after Immersion therein. Waters then
never contain Sulphur except as Hepar.
th
w: it we often find but Gaseous & Salcom=
=prune.

Among the variety of M: S. very few
impregnate Min: waters: partly because
few of them are soluble in water, partly
because many of them are not soluble in
Hydrile Acids, & partly because when they
are dissolved they are liable to Precipitation
th th
by Other Matters w: are diffused thro' Earth.

of Mineral waters

Of all the M.S. except Zinc Copper & Platinum
Iron are most strongly attracted by Acids
are also
and the most frequent Metalline
productions of Nature. Hence therefore
we may expect to find most frequently
Iron in waters, and of these two, the
latter because it is more generally dis-
=tributed thro the Earth, & most strongly
attracted by Acids. They are never founder
=ept in a Calcine State. Iron may be
combined w. Air, Alkalies, or Neutral
Salts, but most frequently w. the first;
yet it is so difficult to collect Green

Of Mineral waters

Vitriol in its proper form from Min: waters

that some have denied the Existence of

Iron in a saline state.

The Difficulty may be removed by con-

sidering that the Acid of green vitriol,

is in a vol: State, so y: when Vitriol

is exposed to the Air it very soon loses

its Acid, & degenerates into an Ochre.

It has been long found y: Chalybiate

Some a certain vivifying Spiritly keeping,

the properties of w: are not exactly known.

There is, not that nitri Air which exhales

the w: the volatile Acid? —

The mineral waters of Copnurau by

no Means so frequent as the Chalybiate,
which depends upon Reasons already
given. Naturalists have supposed ℈ss
the Copper is never present in saline
State, but I have a Specimen of pure
blue Vitriol collected from a Spring in
Britain. The Difficulty of obtaining
blue Vitriol in a Crystalline form as
we said of Green gave Rise to ℈ss Suspi-
-cion of its Absence entirely from Mini-
-eral Waters. The only M.S. remaining we
we can expect to find in Mineral Waters is

Zinc

This is readily soluble in liquor. Spir:
-ritus

of Mineral waters

Iron & Copper from Ø, And is now
found to be a frequent production
of Nature; and yet Chemists alledge y:
it is never found in Mineral waters.
It must be acknowledged y: its pre-
-sence is rarely discovered. Tho I have
been a Spectator of White vitriol from
Mineral water. We are led here to enquire
w: is the Reason y: Lime is so rarely
present in Mineral waters? - Perhaps it
is because Lapis Calaminaris & Luna
Galena are not readily Soluble in Acids
or rather because we never suspect it

in Waters. But do we not not hereby
proper Means of discovering its presence?
— By treating the Residuum of Mineral Waters
w: Copper as in making of Brass we
might always determine whether Lime
is present in any State. —

Earths are found more or less in all
Waters, and none more frequently than
the Species of Absorbent. Calcarious Earth
w: are not soluble in Water except in
a State of Quick Lime, are frequently
found suspended in Water probably
by Solution, Lime Exposure to the Air, &
Several Additions cause a precipitation

of Mineral waters

of Lar the which have been a phenomenon in Dissolution.
— From this Phanomenon we are led
to enquire in w: Manner it is rendered
Soluble? — perhaps by a very volatile
fluid which evaporated: but then
the precipitated Earth would retain some
Marks of Corrosion. — perhaps it is in
the form of Quick lime: but if this is the
Case how can we imagine y: the Calcination
had been effected: this however is the most
probable Supposition: and if found to
be true it will confirm the Opinion that
Lime water acquires its Taste & Power
only from an Impregnation contracted in

Of Mineral Waters

Observing: Some Mineral Waters are entirely without that peculiar taste & Odour. They may not Sensibly affect: dissolved in Wa-=ters disposed them to dissolve Earths &c: Otherwise they would not affect? — These kind of Waters are called petrifying, be-=cause by insinuating themselves between the Pores of Bodies over which they pass, they leave their Earthy particles, & by that means produce Petrifactions.

Crystallized Earths as they are met

Soluble in Acids are never found in Waters except in Such small Quantities as not to form Mineral Water, And even

of Mineral waters

Those Small portions are in a State of
Diffusion Only.

Argillaceous Earths impregnate
Waters as they are partially soluble in
them: but these are most frequently in
a diffusable State. From the extremely
minute Diffusion of w.ch Clays are capa-
ble has arisen the Mistake of Argilla-
ceous Earth in water for truely Saline.
ceous Waters. We have already said y.
water is convertable into an Earth
composed of the Absorbent Angystalline
which are also the Ingredients of Clay.
Query may not all the Clays obtain Earth

Of mineral waters

have been formed thus from water.?

We formerly mentioned 3 species
of absorbent Earth viz: Calcarious
Magnesia & Earth of Alum. These may
be united w: the Fossile Acids into Earthy
Salts tho' we are only acquainted w:
one Combination of the Muriatic. Vit:
Acid, & Calcarious Earth producing Selen-
-nites. This is a frequent Production
since it is very Generally the Cause of
hard waters such as decompose Soap.
They are to be remedied by 1st: Addition
of fixt Alkali. Vit: Acid & Magnesia
form the Spurious Salts of Glauber, &c. is

Of Mineral waters

Abundantly more frequent than the genuine Neutral. they are also often mistaken for Lake Waters. Earth of Alum uniting w.th the Vitriolic Acid is often found in the Bowels of the Earth, & may therefore impregnate Brin: Waters: yet it is rarely found because its Attraction to Acids is weaker than the other Absorbents, than Iron, or Copper. The Combination of Calcarious & Mur: Acid mentioned before is called fixt Ammoniac. this is seldom found Alone, but frequently accompanies Com: & Glaub: Salts. The following is a Table of all the Bodies w.th impregnate Brin: Waters. ——

Table of Mineral Waters.

Aqua minerales simplicissimæ.

ex

Salinis

1ª Alkali Fossili.

2ª Terrestris a. Sale glauberi v. salmarino

Inflammabilibus

1ª Oleosis Fossilibus.

2ª Sulphureis.

Metallicis

1ª Ferro

2ª Cupro

Terrestribus

1ª Calcariis

2ª Argillaceis.

Table of Mineral waters

Aqua minerales Compositæ

ex

1. Salinis variis { Because we seldom find water impregnated with Glauber's without common Salt adhering & vice versa.

2. Salinis Sulphureis - Hepar Sulph. &c

3. Salinis Metallicis, Vitriolis Cupri & Ferri.

4. Salinis terrestribus. Selenitis Sal Absinthe

We shall here subjoin the Table of Elective Attractions.

Explanation of the Characters contained in the Table. ——

⇐ Acids in general.

☉ Vitriolic Acid

☉ Vol: Vitriolic Acid.

☽ Nitrous Acid.

☿ Muriatic Acid

♃ Neg: Acid

♃ B: Acid of Borax.

♀ Acid of Tartar

⊖ Alkalies in general

⊖ Fixt Alkali

⊖ Caustic fixt Alkali

⊖ Volatile Alkali

⊖ Caustic Vol: Alkali.

☉ Neutral Salts.

☿ Ammon.ᶜ Salts.

♃ Phlogiston.

°₀° Oils in general

°₀° Essential Oils.

♃ Sulphur.

▽ Alcohol.

♁ Aether.

Mᵗˡˢ.

M Precious Metals. ♎M.

☉ Gold.

☾ Silver.

BM Base Metals.

♀ Copper.

♃ Tin.

♂ Iron.

♄ Lead

☿ Mercury

♒ Regulus of Antimony

♃ Zinc.

B Bismuth.

K Cobalt.

N Nihil.

P. Platina

♁ Arsenic.

∀. Alkahest Earths.

∇ Quick lime

M Mag: alba.

▽ water.

△ Vegetable Air.

...elaud.

...der=

...two

...d upon

...o has

...uts.

...peated

...o D.r

...tina,

...e has

...ften

...iglet

... Corne

♄ Lead

☿ Mercury

♏ Regulus of Antimony

♃ Zinc.

B Bismuth.

K Cobalt.

N Nihil.

P. Platina

☌ Arsenic.

∀. Alkahest Earths.

∇ Quick lime

M Mag: Alba.

▽ Water.

🜂 Phlogiston.

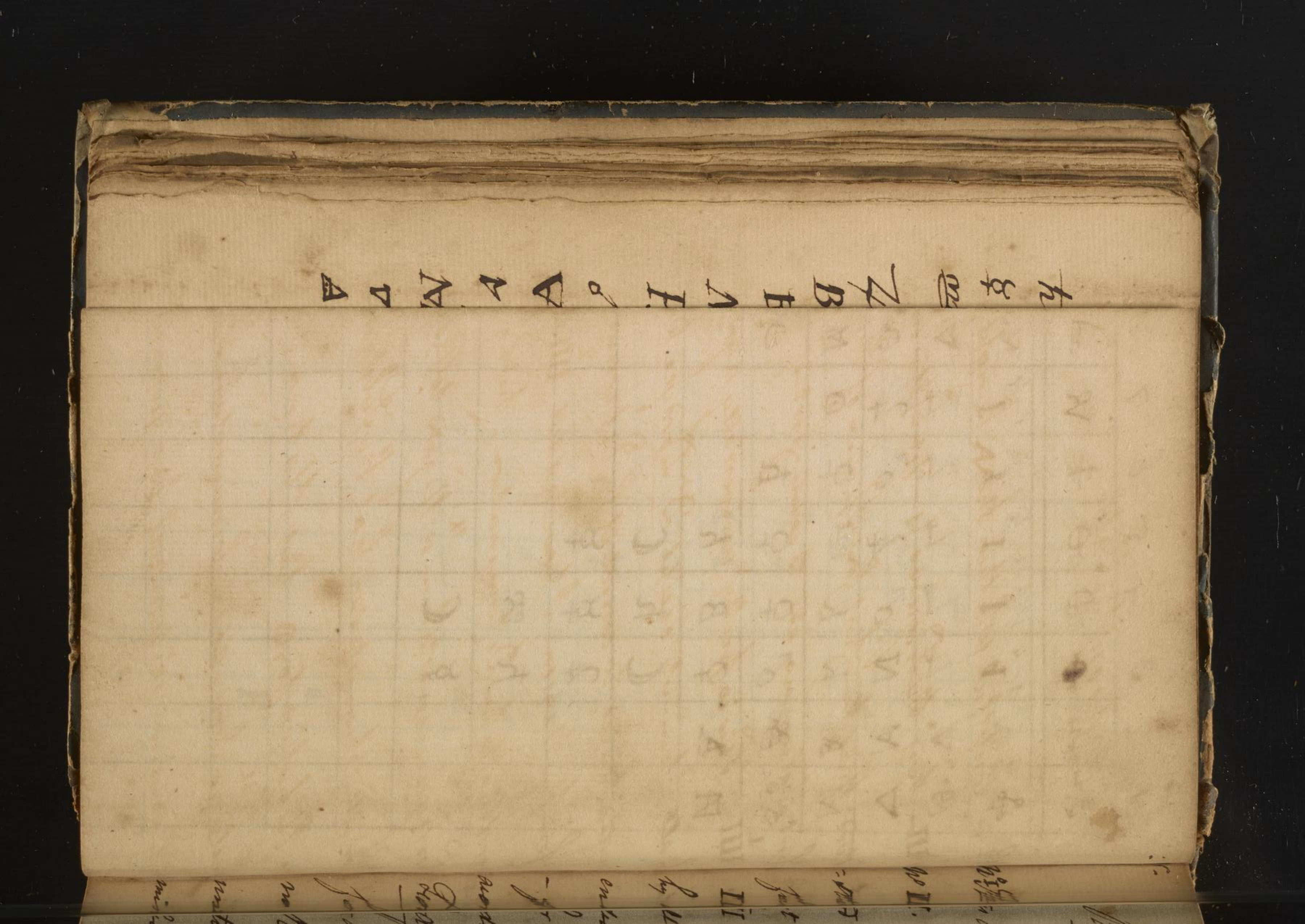
№ 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
☌	☍	☉	☽	☽	☌	☍	☐	☽	☽	△	☌	MS.	♄	♃	☉	☿	☿	♀	☾	☾	☾	☿	☿	♃	♂	♃	♌	♂	♓	♓		2/4
♓	☽	1-4 I	1-3 I	1-4 I	1-4 I	1-4 I	MS.	☽	☽	☽	☍	☽	☽	☽	♀	☽	♀	♀	♄	♄	☿	☉	♄	♂	♃	♂	♑	♎	♃	♉		☽
☌	☿	♎	♎	♎	♎	♎	☿	☽	☽	☽	♈	☌	☌	☌	♈	♀	☽	☾	♀	♂	☼	☾	♉	☍	♂	♂	♂	♂	♂	☽		1-4 I
☿	♏	♑	♂	♃	♂	♃	☽	☌	☌	☌		☽	☽			☽						♄			♄♎	♂		♀	♀			☽
♏	♏	♑	♑	♒	♀	☉	♏	☿	☿	☿		☿	☿									♃						♃	♄			♏
MS.	☽	♂	♀	♀	♄		☽	☽	☽				♓									♀						♄	♃			♎
♋	♋	♀	♉	♄				♉	♉													♎						☾	☾			♐♃
		☾	♄	☾				♓	♓													☌						☉	♒			♂
		♃	♅	♅																									♅			♉
		♄	♒																									♂				♍♂
		♅	☾																													♒
																																♏
																																♐

Remarks on the Table.

1st It is doubtful whether the ♈ be right placed.

2nd III. By the Figures (1—40) it is under=
=stood that the first four Spaces of the two
first Columns are to come first.

3rd $\frac{1}{IIII}$. This is pretty universally agreed upon
by all Chemists except Dr. Lordyce who has
endeavoured to correct it by Experiments.
- For this Reason I have added $\frac{2}{IIII}$ repeated
according to his Determination. Perhaps Dr.
Lordyce is mistaken w.h Regard to Platina,
for all Chemists say that this Substance has
no Relation to ☿. But Platina is often
united w.h Iron, and y.r Circumstance might
mislead him. Mr. Margraf has given us some



Remarks on the Table.

I. It is doubtful whether the ☿ be right placed.

II. By the Figures (1—144) it is understood that the first four Spaces of the two first Columns are to come first.

III. This is pretty universally agreed upon by all Chemists except Dr. Lordyce who has endeavoured to correct it by Experiments. For this Reason I have added IIII repeated according to his Determination. Perhaps Dr. Lordyce is mistaken w.h Regard to Platina, for all Chemists say that this Substance has no Relation to ☿. But Platina is often united w.h Iron, and y.r Circumstance might mislead him. Mr. Margraf has given no Com-

Remarks on the Table.

Experiments 1st very much disturb the
Column of 0. he finds that tho' Spirit:
=itus Cosperi in the Cold, yet in that
the contrary happens. perhaps this depend:
upon a principle that Heat encreases
the Action of Bodies when seperate, but de:
=minishes it when they are combined.

VIII. This is a new Inquiry & ancerta:
=nely useful one. Dr Alston for preserving
Water at Sea proposes that a Quantity of
Lime should be thrown in. this gives it the
Properties of Lime Water in which State it
will keep for Ages. When it is to be used he
directs that Magnesia shd be added. this

Remarks on the Table.

is Soluble in water, but furnishes Air to q:
Lime, w: th^h^ falls to the Bottom w: it. and
leaves the the water pure. I plan m: S: ap:
=proach because the Addition of mild calca=
=rious Earths restores them from Calces to
a Metalline Form. —

IX. I have put the ☉ and ♃ together, for
I do not know whether there is any Differene
in their Attraction to ☉. Balsam of Sulphur
may be united wholly w: th^h^ ☉r into a Soap.

XII. I have not given a detail of the
Fluids in this Column; tho' they are in the
same Order as in the 9: & 10: th^h^ Columns.

XIII. This stands as given by Geoffroy=

Remarks on the Table

But it is most doubtful of all, and you
see the two next columns are Exceptions
to it.

XIV. Possibly ☌ – may in like manner
come in with ♃.

XVI. perhaps this is not well founded,
tho agreable to common Experience: I rather
think the Column shd. stand thus

XVII. This shews that the ☿ only takes
the water that enters into Moisture w: it
in Order to Crystallization, and that when
it has acquired ȳ: and in a mild State then
♀ will precipitate ☉ or from ▽.

XIX. This Character ☌ stands here for

Remarks on the Table

all Inflammable that are Soluble in

V.

XXII. I have not ascertained by my own

Experiments the Truth of this Columns.

XXV. This is for the Seperation of Finand

Silver. —

36

Of the Chemical History

of

Fire

Of the Chemical History of Fire

Shall endeavour to deliver, briefly: we can undertake to deliver, will be something of the nature of this History of Fire: an Agent universally found, and the most important to the present purpose, as leading to the general History of Qualities.

In treating this subject I shall pursue the Analytic Method entirely; taking care not to advance new Theories, or such as being ill grounded may lead to Error, but to collect & digest in proper Order those Facts which have any Relation to

Of Fire

The Business in hand. Perhaps you
I shall reason on some Facts,
(for this is extremly allowable) & draw
perhaps a few unexceptionable Propo
in general however I shall only enum
=rate known Facts; and those as they are
relative 1: to the Generation of Heat
2nd: its Communication & 3d: as they are
relative to its Effects.

we shall first treat of 4: Generation
of Heat. —

Of the Generation of Heat

It may be enquired that I should here give a Definition of Heat or Fire. but this is very difficult, & perhaps not to be attempted by us: we can only attain a full Induction of Facts. it is only necessary to premise here y: by fire here we mean that power w: excites y: Sensations of Light and Heat. these are usually joined together, a certain degree of Heat producing Light, and this in a certain proportion according to Heat.

Some Philosophers in y: Subtile Reasoning have argued y: the term Quan:

Of the Generation of Heat

Generation is improperly applied to Heat. for they say, Heat is only collected from heated Bodies, being thus communicated by Bodies to each other; hence they conclude that no Heat can be properly said to be generated. Again Heat always endeavouring to restore itself to an Equilibrium will be urged: Lastly diffused from a heated Body to a number of similar & contiguous Bodies till all of them acquire equal quantities of Heat & hence if one Body be more heated than the rest it will

Of the Generation of Heat

Some do much of its Heat as is sufficient
to restore an Equilibrium between all
the Bodies. But if by any Contrivance
Heat can be produced in one Body without
diminishing it in another, surely in
that Case we may say w: probriety:
Heat is generated.

The Means of producing Heat in Bodies

are various. The first shall treat of
is the Increase of Motion excited in any
Body, tho w: some have objected to this reason:
ed the Increase of Heat. This is effected by
Mechanical Means & is therefore called

Of the Generation of Heat

The Principal Generation of Heat. Heat is produced either by Attrition, Percussion or Collision. Altho' Heat may in some Degree appear to be the Cause, yet it is requisite first to consider them separately.

1: Attrition or Friction. Common Experience informs us that by this means a Heat may be excited between two Bodies so as to produce Flame. We may here observe as it is not foreign to our purpose that no Heat can be produced by Attrition in Fluids. — The Reason may occur in Burning Glasses at first

Of the Generation of Heat

Light to prove y^e^ contrary. but we
must consider y^t^ in those as well as
many other Cases the Heat produced
is owing to a chemical Decomposition.
How soon ^2^ till it is proved y^t^ simple ba:
- pro genero Fluid can be rendered
not by Agitation I cannot allow y^t^
they are capable of producing Heat. we
find also y^t^ ~~the~~ Solids produce a greater
Degree of Heat as they become firmer, &
are further removed from a fluid State.
- thus Stone produces more Heat than
Wood, & Metals still more than either.

of the Generation of Heat

the next Circumstance for determining

y^e Quantity of Heat to be produced in any

Body, is the Roughness of y^e Surfaces

applied & moved on Each other. by this

means they impinge & cause Oscillations

one more or less frequent in proportion

to the Number of ~~Oscillations~~ Protuberance

this admits of Demonstration: for as

the Surfaces of Bodies become more

polished less Heat is produced in them

by a given Quantity of Friction. —

Mechanics find than a Gudgeon

of Steel will turn much easier in

a Brass, than a Steel Gorget. —

Of the Generation of Heat

According to Muschenbroeks Expansion?

they differ also in the time of acquiring
Heat, and have Diff: Quantities of Ex:
-pansion in the same Degree of Heat: it
is not easy to say whether this Difficulty
of Motion happens because of Attrac.
: tion of Iron to Iron is stronger, or be:
=cause the Inequalities of Iron are
better adapted to the same Mutation
to those of Brass. we may likewise Ob.
=serve that when Iron is employed a
Degree of Magnetism is acquired, & hence
the parts worn off by still adhering con:
=tribute sooner to y^e^ Grinding away of a

Of the Generation of Heat

Gidgeon in an Iron Pan in a brass
Socket. But as we seldom or never
can obtain a polish so perfect as en-
=tirely to prevent the Generation of Heat
it is necessary to interpose some substan
capable of filling up all Irregularities
of the Surfaces. The most Spiritual for
this purpose are Oil and Black Lead;
or
w: last may be reduced to an exceeding
impalpable powder.

The Roughness of Surfaces, & the hard
=ness of Bodies being given, the Degre
of Heat will be proportionable to the
Impetus applied, & this Again depends

of the Generation of Heat

upon the Quantity of Matter & Velocity of the moving Body. Velocity encreases the Momentum, & accumulates the Vibrations by wch they become more dense, or a greater Heat is generated. This may be proved by pressing a Rope slowly & then very rapidly thro a Body: it will be found that a Degree of Heat in the latter Case will be most considerable. Here a Question may be examined whether the Increase of Quantity of Heat produced, or the Heat produced, certainly does in some Measure, as the Centers of Oscillations are encreased

Of the Generation of Heat

in Number. The Rule to be observed
herein is this, That as the
Surface does not compensate for Dimi-
-nution of Velocity. for if the Edges, and
then the Sides of two broad thin Bodies
be rubbed together w.ª a given Velocity, the
Heat produced will be greater in y.ª Latter
Case; but if the Velocities in each be re-
ciprocally proportional to the
Surfaces applied, the Heat produced by
the Edges will be less y.ª more considera-
-ble. contrary therefore to what undoubted
Experiments Mr Martin in the
Div.n and Mr Hays alledges y.ª Diminu-
-tion of the Velocities is contrived to in-

Of the Generation of Heat

disburse the Heat equally thro the
whole Body, the extent of Surface in
that Extremities wnthus exceeding some
slower motion.

The next proposition I shall lay
down is, 4ly: Any Body must be fixed
in Order to have Heat produced by the
Friction of another. This may be con-
firmed by various Experiments. As 4ly:
if a piece of Iron be fixed in a Vice in
Order to be filed, or a Rope be pulled
rapidly thro a fixed Block, we shall find
4
ly: a great Degree of Heat will be excited
in the fixed Bodies, while 4ly Movable

of the Generation of Heat

have no Heat at last w: they receive from
being in Contact w: the heated Bodies
If both the Bodies be moveable the
Loss sustaind by the moving Body w:
be chiefly spent in causing y: motion
of the Whole, and not in producing Os
Oscillations. Since it is plain y: Heat
cannot be produced by the motion of
Fluids on Fluids because Fluids can
not be fixed. This Conclusion is further
proved by Observing y: a Fluid interpos
between two Solid Bodies prevents the
Generation of Heat. in Answer to this
however Several Objections are adduced.

Of the Generation of Heat

as the Heat produced in Fermentation;
but this is certainly owing to a Decom-
position of parts, and is Nothing to
the present Inquiry.

As Arguments &c. This Opinion it is
alledged that Iron & Silver agitated in
a Vial, and a Cannon Ball discharg:
both acquire considerable Heat. I
grant that Heat is produced in both
Cases, but at the same time I must
observe that the Instances are by no
means conclusive. for in the first
Case the Mercury is agitation is chang:

Of the Generation of Heat

into a solid powder, wch being rubbed
by the sides of the Phial will un-
doubtedly produce Heat. in y^e
Case the Bullet is surely heated even
much by in shaping from y^e Gun
Violent Attrition by its sides &by
the Inflammation of the powder.
Wch therefore it is proved y^t y^e Bullet
grows gradually hotter from y^e time
it is discharged from the Mouth of the
Cannon, no certain Conclusion can
be drawn from the Heat. upon the
Whole we may conclude Heat

of the Generation of Heat

can be generated in Fluids by any Me=
chanical Motion, & hence y^e Absurdity
of the Theory by which Animal Heat
is supposed to depend upon y^e Attrition
of the Fluids &c. each other, & y^e Sides
of the Vessels. It is further to be observed
w^th Respect to the Mechan: Generation
of Heat, that it depends rather upon
the State of Aggregation than upon
Mixture; and particularly y^t it does
not depend upon y^e Quantity of Phlogiston
contained, except when we desire to
excite Actual Flame, & then y^e Body
containing most Phlogiston is to be

Of the Generation of Heat

shown. Even Stone by Attrition a[illegible]

more Heat than Wood. Tho' Wood con-

-tains by far ~~a~~ the largest Quantity of

Phlogiston or inflammable matter.

This takes place even in different

kinds of Wood. E.G. Mahogony is

capable of more heat from Attrition

than any other Wood, altho' they

may contain more Phlogiston. We

may make the same Observations on

m.S. - Iron is capable of having more

Heat excited than Lead, & indeed it has

more inflammable matter. but Lime

& w: contains more Phlogiston than

Of the Generation of Heat

Iron is far less capable of Heat by Fric-
tion. The Quantity of Heat produced
thereby depends in a great measure
upon the Hardness of Bodies, & consequent-
ly on the State of Aggregation, and not
of Texture, except so far as the latter
influences the former.

Thus then we see it is from y Oscillations
produced in any Body that its Heat is
generated. That Oscillations are supposed
to be excited in a very Subtile Fluid,
interposed between the Particles of all
Bodies, w^ch from Sr Isaac Newton who
tho not the first Discoverer was y first

Of the Generation of Heat

Author who treated the Subject fully has been called y^e Newtonian Philosophy.

That such a Fluid exists is at present the generally received Opinion. it is not convenient for me now to enter far into the Dispute. I shall only observe that upon exciting Motion in any Body a new subtile matter seems to be introduced into the pores. now although this is very probable; yet it must be Objected, that if it was really true, the same Motion Ch: produce Heat in proportion to the Number of contiguous Bodies. this however does not happen. for this

of the Generation of Heat

the Heat of the surrounding Bodies diminished. in Electrical Experiments the matter is collected & accumulated in the Body without Diminution of it's quantity from wch it is derived. these Arguments however are not conclusive: for can any thing be determined wch certainty till a Method is found of stopping the propagation of that as we do that of Electrical Matter. here a Question occurs that I shall propose without attempting to answer. Whether or no the common Hypothesis that Heat does arise from the Influx of a subtile matter, is not Heat excited in this matter owing to Agitations?

Of the Generation of Heat

It may indeed be remarked y^t Fire or its Matter is common to all Bodies without Respect to them as Mixts.

The Agency of Fire is so very extensive, that the Explanation of it requires par. ticular Attention. in Order to do this, the several Facts relating to y^e Subject ought to be collected: but this is a da. : bour ch: few are either willing or able to accomplish. Many of the many Hy: : pothesis ch: have been formed I shall only mention the three principal.

The 1: of these Opinions is, y: the Heat of Bodies depends on Motion, & one

2

Of the Generation of Heat

particular modification of this motion.
This was first started by Lord Bacon &
followed by Sr Isaac Newton who says in
a Query at the End of his Opticks that
Light, and Gross matter are mutually con-
-verted into each other.
The 2.nd Opinion is that Fire demands
upon motion, but that this motion can
be obtained only in particular species
of matter containd more or less in all
Bodies. This is followed by Foreign
Philosophers.
By the 3.d Hypothesis Fire is supposed to
depend upon motion peculiar to the

Of the Generation of Heat

Or Subtile Elastic Fluid Alone, w^ch is called formerly the Newtonian Ether.

This is the Opinion most generally received, & w^ch seems to be best confirmed by the Experiments relating to y^e Production of Heat by Attrition & II^dly Of Percussion. This is y^e Second Mechanical Means of producing Heat, by w^ch is meant chiefly Hammering. it is for the most part applicable only to Metals. Stone, Semimetals, & hard Woods not admitting it upon y^e Accn of y^e Friability or Weakness of Texture.

For the Production of Heat by percussion

of the Generation of Heat

In two things are necessary 1st: a firmness of Cohesion in Attraction to Solidity or Friability. 2nd: a quick Repulsion of the Strokes. Thus Iron may be hammered till it is red hot.

That the Body to be heated must be fixed in this Case, as well as in y^e Case of Attri: tion Arises from several Circumstances. E.G. The Striking Hammer being move able is almost cold, tho' a piece of Iron be beaten w^th it on an Anvil till it is almost red hot. Again when a Nail is driven up to the Head in a piece of wood, so that it can be forced no further, a few Strokes will render it

Of the Generation of Heat

very hot; whereas many Strokes will not have the same Effect while it continues to move.

From all y^{t} has been delivered upon this Head, it appears that y^{e} Heat generated by Percussion is owing to a Tremor or Brillation excited.

III^{d}: of Collision. This is the third Mechanical Means for generating Heat. I shall attempt an Explanation of this, tho' it is an extremely difficult task. Collision is a slight Stroke of two Bodies ag^{t} each other, chiefly of M^{r}. Stones & Compositions Substances, not as being better adapted for it by any particular

Of the Generation of Heat

Quality in consequence of their Mixture;
for Argillaceous Earths may be difficult
hardned by Art to produce the same Effects.
It is surprizing to see the Degree of Heat
produced by so slight an Impulse. it has
is sufficient to fuse even Iron w: is
among the Bodies of the most difficult
Fusion. Nothing is more difficult
to explain than this Phenomenon in
the whole Theory of Fire. we shall however
observe 1st: at every Stroke a small
particle of the Body flies off. this does not
happen from the Force of 1st: Stroke, but
from the Elastic Fluid accumulated at

Of the Generation of Heat

Heat please w.ch by its extraneous force throws off the particle. Something like this happens in Bologne Bottles w.ch are made without annealing. for if a Bullet be dropped into any one of these, it will not fracture it. but if a piece of Glass or any such Angular sharp substance be employed, the Bottle will immediately shivered to peices.

The ready Breaking of thick glass Vessels upon the sudden Application of Fire cannot be accounted for, but by the Accumulation & Expansion of the Subtile Ether as in the former Case.

Of the Generation of Heat

The Inference drawn from my foregoing Experiment relating to Glass, may be further illustrated by recollecting that Glass bubbles are able to bear a very considerable pressure & w: may be broken to pieces by a very slight stroke. And upon the whole tho' as I said before it is extremely difficult to deliver any thing complete upon the Subject of Collision, yet one may be allowed to confirm a Belief of our general Proposition "that Heat is an Elastic Fluid in all Bodies more or less according to their State of Aggregation,

of the Generation of Heat

"and that by exciting Tremor or Vibra-
tion in this Fluid, all mechanical
Generation of Heat depends".

Fire being already considered as
produced by mechanical Means, is here
to be treated as generated by y Intes-
tine or Combination of various Bodies
Here the chief Difficulty is y Theory of Air
arises: for in Cases of Mixture y Heat
does not seem to depend upon Motion, but
on the different properties of y Substances
to be combined.

Before we proceed to Particulars, it
will be necessary to lay down a few
General Propositions.

Of the Generation of Heat

1. All Chemical Combinations pro-
duce either Heat or Cold greater than
either Body contained before Mixture.
We must however observe 2. that Degree
of Heat or Cold cannot be always ascer-
tained. For as the Change of Temperature
in Bodies, is encreased proportionately to
the Quickness, & some other Circum-
stances of the Action; so when these
Circumstances are any way abated, the
Change of Temperature becomes improp-
portion'd obvious to our Senses. Thus
in the Solution of Selenitic Salt in water

Of the Generation of Heat

Only a few Grains are dissolved in a Pint, & a considerably time is required for the forming even this Solution. It is a very necessary tho' laborious Task to enumerate all such Combinations. Many have attempted this, & have enumerated prodigious Numbers of Mixtures. M.r Musschenbroek for Instance reckons more 4/4 300. & when 2/4 plain w.h he followed he might have reckoned several hundred more. This Superfluity arises from an Ignorance of a proper Chemical System. I have made the following Table upon a

Of the Generation of Heat

different plan. Nor I will not pretend to say are faultless: but only y^t they render this part of the Subject Less intricate to the Learner, than y^e perplexing Number of Combinations enumerated in some Authors.

I shall first give You a Table of the heating, & then of y^e cooling Mixtures, & after each a few general Remarks on the several Articles. —

Table of the Heading Divisions.

I Acids w.ᵗʰ Alkalies

— with Neutrals containing Or

— with Soap & Hepar Sulphuris

Metallic & Earthy Salts w.ᵗʰ Soap & Hepᵃʳ Sulphuris

Sulphur with Alkalies

Ammon.ᶜ Salts w.ᵗʰ fixt Alkalies

Metallic Salts w.ᵗʰ fixt Alkalies.

Ammon.ᶜ Metallic & Earthy Salts w.ᵗʰ Neutrals.

II Acids w.ᵗʰ Oils.

— w.ᵗʰ Animal & Veg: Bodies

Ammon.ᶜ Metal: & Earthy Salts w.ᵗʰ Oils & oily Bo:
dies.

III Acids with Alkohol

Metallic Solutions w.ᵗʰ Alkohol y Attracts y Acid.

IV. Acids w.ᵗʰ Metallics

— w.ᵗʰ Metallic Salts

Sulphur w.ᵗʰ Metallics.

Neutrals w.ᵗʰ Metallic Salts. —

Table of the heating mixtures.

Ammon.c Metallic & Earthy Salts w.th Metallics.

V. Acids w.th Earths.

—— w.th Earthy Salts.

—— w.th Animal & Vegitable Substances.

Sulphur w.th Earths

Ammon.c Metallic & Earthy Salts w.th Earths.

VI Acids w.th water & watery Liquors.

—— w.th Animal & veg.e Substances.

—— w.th Air.

- wine w.th Water

Metallic Solutions w.th water & precipates them.

VII. Acids w.th Acids.

VIII. Alkalies w.th Inflamonables.

IX. Alkalies w.th metallics.

X. Alchohol w.th Reg.o 7.

XI Alchohol w.th water & watery Liquors.

— w.th Animal & veg.e Substances.

— w.th Solutions of Salt.

Table of heating mixtures.

XII.	Mercury w:	th Metallics.
XIII.	Metallics w:	th metallics.
XIV.	water w:	th Calcined Salts.
	—— w:	th dilaquescent Salts.

Remarks on the Table.

Article I

Vol: Alkali has been long thót to ge:
=nerate Cold w: th Acid: but later Experience
proves the contrary. for if thrown in to wa:
=ter it generates Cold. w: th concentrated
Acid it generates Heat. now if the
Acid employed be very dilute, the Cold
geninated by the water w: th it contains may
be greater than the Heat generated by the
Acid, or they may be so proportioned as
precisely to counteract each others Effects.

Remarks on y^e heating Mixtures.

& by that means produce no Change of
Temperature on the Addition of the
Alkali, & hence the Foundation of this
erroneous Ancient Opinion. if the Alkal:
is in a caustic State more Heat will be gener:
:ted than if it was mild. The other Heads of this
and indeed of all the other Articles do not
produce their Effects except when a Combi:
:nation takes place.

Article III. This is properly made a Separate
Article, for tho' some Alledge y^e Alcoholic
a Composition of Oil & water, yet the Oil
does not exist formally in it, and y^e Heat
generated is greater than that of Acid w:
the
simple water.

Remarks on the Table of Heats

Article VI. The water must here be supposed in a State of Fluidity.

Article VII. It is rather doubtful Whether the Heat here produced depends upon the Action of Acids on each other, or on the water which they contain. I think the former the most probable Supposition, because a tertium Quid is produced, & the Heat generated is greater than the small Quantity of water contained in concentrated Acids could be able to produce.

We shall now proceed to the Table of cooling Mixtures. —

Table of cooling Mixtures

1 Acids w.th Bodies exhaling much vapour

2 water w.th Crystalline Salts

—— with Ice.

3 Ice w.th Saline Bodies.

4 Ice with Alchohol.

5 Alchohol w.th Ammon.ac Salts.

6 Alchohol w.th Oil.

7 Oils with Oils.

8 Alchohol w.th Soap & Stephan & Sulphurics

Of the Generation of Cold

Remarks on y^e^ Table of Cooling Mixt^s^

Article 1: Acids applied to Vol: Alkali generate heat. but the Exhalations of Acids arise from the Addition to this Alkali in a compound State overcome by this cold the Heat Attending the Solution.

Art: 2^nd^ The Combination of Ice and water is extremely curious. for if the water be heated to 50^o^ & the Ice at 32^o^: the Thermom^r^ will sink to 32^o^ during the Solution.

Article 5^th^ Perhaps this Article might have comprehended w^th^ propriety all the Crystallized & Efflorescent Salts.

After this general View of y^e^ heating

Of the Generation of Heat

a cooling Mixture, it will not be
sufficient to add some general Ob-
servations thereon. in the first place
these Tables contain all y^e Chemical
Combinations in w^ch any Change of
Temperature can be observed.

In the Combination of Earths & Metals
the Change of Temperature cannot be
observed, because a very intense Heat
is required to unite them. the Generation
of Heat always happening upon those
Chemical Mixtures is extremely difficult
to be precisely determined. it chiefly
depends upon y^e proportion of y^e Matters

Of the Generation of Heat

added. Thus Sal Armon: may be dissolved
in water in the proportion of One to three
and if Lef of the Salt is employed a pro=
portionably Lesser Degree of Cold will be
produced. Heat is most effectually & most
plentifully produced when the Mixture
is done at Once, & not at several In=
tervals, & hence the Means of exploding
the Union of Bodies are to be employed
when we would obtain the greatest Heat.
as for Instance in forming a Mixture in
Open Air or in Vacuo, according as it
takes place more readily in One than the
Other.

To obtain the greatest Degree of Cold

Of the Generation of Cold

Let a superabundant proportion be employed of the Body producing Cold. - Then a Question arises Whether by combining a large or small Quantity, more Heat or Cold is produced than is proportionable to it: Quantities added? For my own part I can find no great Difference because the Heat or Cold communicated to the whole Bulk is in proportion to the Quantity required. we may sometimes perhaps observe more Heat or Cold in a large Quantity: but this happens

of the Generation of Heat & Cold.

Because such Bodies are a longer time
time in acquiring & loosing Heat than
smaller. Heat & Cold produced in a way
of mixture emerge in a certain pro-
portion whatever may have been
their Temperatures before Mixture. thus
♎ and first Alk: generately Mixture
100° of Heat more than Ordinary, 100°:
if they were heated to 140° before Mixture
they would on being united produce 140°:
if to 60°: they w: produce 160° Degree of
Heat, & so on in the same Ratio. This
Observation is applicable to ℄ cooling

of the Generation of Heat

Mixtures. When a Body w:h we desire
to freeze contains a considerable De-
:gree of Heat, it is very difficult to reduce
it to the freezing point, because the
Mixture Applied must be much below
that point. Thus if the freezing Mixt:
be at 26: w:h is 6: below the freezing point, and
the Body to be congealed be at 40, no
Freezing can be Obtained, for the
intermediate Degree between those two
Viz: 36: is above the freezing point.

From considering this Subject it
appears that the Notion of Caloric in

Of the Generation of Heat

and Frigorific particles is without
Foundation. For these Effects do not
arise, or at least are not inseperable
from any peculiar Matter: the same
Bodies being capable under proper
Management of producing either
Heat or Cold by the same Operation.
- Thus water poured upon calcined
Neutrals produces Heat & crystallizes
them; and if the Addition of water
is still continued it produces Cold.

of the Generation of Heat.

Ice & water differ only in their State of Aggregation, & yet produce opposite Effects: nor can those Effects arise either from the Absence or presence of Phlogiston, since Acids and water Substances the most uninflammable produce Heat, while Alcohol & Oil &c: are remarkably inflammable produce Cold. even when Phlogiston is present, & in some mea: : sure influence the mixture, the Heat or Cold produced are by no means proportionable to y: Quan: = tity

Of the Generation of Heat

Thom's. For Instance Heat produced by the Combination of Acid & Metals is equal to, or perhaps greater than that resulting from a Mixture of Acids and Alk. from w: has been said then Our Proposition will appear true "that the Change of Temperature indeed depends on the State of Aggregation"

Acids become the Basis of numerous heating Mixtures from their great Affinity to other Bodies, being almost

of the Generation of Heat

universal Menstrua. before we pro-
=ceed further it may not be improper
to constitute an Accurate Distinction
between Mixture & Solution. by Mix-
=ture the Substances loose their peculiar
properties, & form a tertium Quid. by
Solution the Substances possess y^e same
properties as before except y^t they
are changed in their Form of Aggre-
=gation. thus Alkali thrown into
Water is changed in its Texture and

Of the Generation of Heat

reduced to a fluid State. still however
retaining its particular Qualities;
but if joined w^th Acid the properties of
both become entirely changed, & a
Neutral will be produced differing in
Quality from either. Mixture takes place
in a certain proportion of y^e Ingredients,
beyond w^ch either may be added without
Effect of Mixture; tho' by adding a su-
perfluous Quantity of y^e Solvend a
Solution may be Obtained. in Mixture
only two Ingredients, in Mixture

Of the Generation of Heat

many may be combined at ꝙ same
time. in some cases of Miniature
this Observation may appear not
true. E.g.: It may be objected that
the three Ingredients Acid, Phlogiston
& Alkali are required for ꝙ production
of Kepar Sulphuris, but then let it
be Observed that ꝙ: Acid & Phlogiston
must be united before a Sulphur can
be formed. w^h: afterwards uniting w^h: ꝙ:
Alkali produces a Hepar: Indeed if ꝙ:
Objection takes place here, it may also

Of the Generation of Heat

be admitted Rg: very Combinations.
for in none of them are pure Elements
parts employed. There is also a conside-
rable Difference between Solution and
Mixture in their Decomposition. For
in Order to decompose Bodies combined
by Mixture, greater Heat is requisite
than w: have volatilized them in a
Sepera te State. Whereas if Bodies are
united Only by Solution, that Degree of
Heat w: would volatilize them in a Se-
parate State, would also volatilize

Of the Generation of Heat

from when ~~separate~~ dissolved. This from
a Solution of Neutrals y^e^: Superfluous
Water may be readily exhaled, While
an Intense Heat is required for the
Dissipation of that portion necessary
to Crystallization. upon the whole
I think we may conclude y^e^: When
Mixture takes place Heat is generated,
when Solution Cold. Three Cases in
w^ch^: Heat & Cold both happen will
be readily understood from an Attention
= tive Consideration of y^e^ foregoing

Of the Generation of Heat

Tables. we may also conclude y^e in
three Cases Heat is produced by Motion.
as in the Mechanical Generation.
much however depends upon y^e Manage-
ment of the Air 1.^o Cold may be produced
by the Rarefaction of y^e Air as we may
prove by the Air-pump. 2.^do Cold may
be produced in Bodies by restoring their
first Air to an Elastic State. & 3.^o Cold
may be produced by converting Bodies
into Vapour.

These Experiments are very useful.
would be more so if the Convers of these

Of the Generation of Heat

could be exhibited: but this can be done in the first Instance Only, in which an Increase of Heat may be perceived by restoring Air to anes=
=austed Receiver, or Again Rids or Alchohol combined with water Shew an Increase of Heat & a Diminution of Bulk from Condensation. we may Observe by way of Illustration to this Subject, That as an Elastic Cord when It receives a Stroke, has quicker Vibra=
=tions according to the Increase of Tension;

Of the Generation of Heat

So in Heat occasioned by y Undulations of an Elastic Fluid, the vibrations will be fewer in proportion to y Diminution of Density in that Fluid by the Rarefaction of the Air, & consequently a Generation of Cold may be effected.

We are now to consider y Generation of Heat by means of Fermentation.

By Fermentation is here meant every kind of Assimilating proces. in all these Heat is visibly produced, but more especially in the three most noted

Of the Generation of Heat

Spirits, the Vinous, Acetous & putre-
-factive. in the last of which so great
Heat may be produced as to excite actu-
-al Flame. in the Acetous & Heat gene-
-rated is less. & in the Vinous least of
all.

Philosophers in general think Heat
is generated in Fermentation by Me-
-chanical Means: but they are
certainly mistaken, if we admit ye
Supposition that Heat is not to be produ-
-ced by the motion of ye particles of
Fluids Against Each Other. Besides ye

Of the Generation of Heat

Heat generated is not proportionable
to the intestine Motion. For in the
vinous Fermentation there is y^e greatest
Motion, and least Degree of Heat, Whereas
in the Putrefactive there is y^e greatest
Heat, and least Motion. I am inclined
to think from all those Phaenomena
that the Heat in Fermentation depends
upon a Decomposition & new Combina=
=tion. But the whole Theory of Fermen=
=tation is so imperfect that we
can deliver nothing w^th Certainty
upon it. —

Of the Generation of Heat

We next proceed to consider y^e^ Genera-
=tion of Heat in Animal Bodies. a
subject of great Importance, but extreme
=ly difficult to be treated in a proper
manner. Heat is observed to be greatest
in breathing Animals, and of those
greatest in such as breath most plentifully.
very small Insects may likewise be
observed to have some Heat by apply=
=ing a Thermometer to a Number of them
together. in the same Class of Animals
Cæteris paribus the Heat is nearly the
same. thus in the human Species it is

Of the Generation of Heat in Anc: Bodies

generally between 90: & 105: .

It is very difficult to investigate the causes of Animal Heat. For this purpose Authors have form'd various Hypothesis, the chief of which I shall enumerate.

1: Animal Heat is supposed to depend upon Fermentation, particularly of the Putrefactive kind. That this Fermentation generates heat is beyond a Doubt. nay it is as certain as y: such a Fermentation occurr in y Animal Body: yet those Circumstances show: ever

of Animal Heat

favourable to the Hypothesis are by no means sufft: to overcome the Objections that may be raised agt: it: For 1st we may Observe that the Putrefaction in living Animals never rises so high as to produce the Heat we Observe in them. It may also be added that tho' Fermentation may produce considerable Heat in Animal Bodies; yet this only happens when it is advanced so far as to destroy the Texture of the Body. This Putrefaction is

710

# of Animal Heat

is sometimes observed in Animal
Fluids, tho never except in a morbid
State.

a 2.nd Objection is, that Heat produced
by Putrefaction is so slow, that it is
lost as soon as generated. Some indeed
imagin that the putrefaction tho'
slow is constantly kept up by the
Food taken in: but I think y.e Oeth
Aliment as we take in, is often Antis-
-ceptic, wch according to this Hypothesis
shd. tend to the Diminution of Animal

Of Animal Heat

Heat.

a3: and a very strong Objection is y: in sentient Masses y: Heat is in pro-portion to the Quantity of Matter; whence we find that in Animals of y: same Order the Heat is nearly equal tho' they differ considerably in Bulk. for Instance we find y: Heat of a Mouse, is as great as that of an Elephant.

These Objections alone seem sufficient to prove the Fallacy of this Hypothesis. Tho' we might add further that y: Heat of Animal Bodies is not proportionable

# of Animal Heat

to the Degree of Putrefaction: in putrid
Fevers the heat is not so great as in
some of the inflamatory Kinds may
it is sometimes below y^e^ natural Stan-
dard. The same may be observed in
the Scurvy; for when this Disorder is so
violent as entirely to corrupt y^e^ Ani-
mal Fluids, the Heat is lower than in
many other Cases. Besides y^e^ Heat of
putrescent Matters cannot be encrea-
-sed by extraneous Motion w^ch^ we see
happens in Animal Bodies: but is
rather effected in a contrary Manner.

of Animal Heat

4: a still more conclusive Objection is
that Animal Bodies putrefy most
quickly when all the vital Functions
cease, and yet notwithstanding y^e^ great
Degree of Heat produced here, the Corpse
will be very little hotter than y^e^ surround-
-ding Atmosphere. I think we may
therefore safely conclude y^t^ Animal Heat
is not the Effect of Putrefaction.

a Second Opinion is that Animal
Heat depends upon certain Decompositions
& new Combinations going forward in
the Body during Sanguification: but in

# of Animal Heat

this Case the Heat will be proportionable
to the Quantity of Food, & the Excretions
performed; and that this is not y Case
appears from such Animals as sleep
half the Year; for in these y Heat remains
nearly the same during y sleeping Season,
tho' they not receive any Aliment:
& consequently cannot be supposed
to have much by Digestion. if there is
a Diminution of Heat in these Animals,
or in a Man who fasts for several days,
it is owing probably to a want of Exercise.
a 3rd more specious & more generally

Of Animal Heat

received Opinions y: Animal Heat
depends on Motion excited by Mechan:
Means. That it depends chiefly upon
Motion appears evident from y: Dimi:
=nution or Increase of Heat on y: slower
or quicker Motion of the Blood. & to demon
=strate in w: manner Motion produces
this Effect, various Hypotheses have been
proposed. we have already endeavoured
to prove the Absurdity of Dr Boerhaave y:
Animal Heat is owing to an Intestine
or Fermentative Motion of the Fluids. I
think the Opinion of those who attribute

# of Animal Heat

it to the Action of the Fluids &c. Each
other will appear equally groundless
from the following Fact. if Blood be
received from the Body in a Vessel con-
taining a Fluid equally warm, by the
most violent Agitation ℈ij Miatura
will not receive any additional Heat,
but in a short time become cold.
It is more generally alledged ℈ij Heat
is owing to the Attrition of the Fluids &c.
the Solids. This Opinion is easily confuted,
for to the Generation of Heat by Friction,
the Surfaces shd both be uneven, nor

of Animal Heat

Should there be a Fluid interposed be-
tween them, the Reverse of wch has
been in the Animal Body. Besides
neither of the Bodies are fixed, conse-
quently little or no Heat can be gen-
erated. Finally the Fluids do not
move wth sufficient Velocity to produce
Heat. This is ye Argumentum fou-
cis wch many have endeavoured to
elude. Some suppose that ye Increase
of Sursaturates & Diminution
of Velocity, & upon this Dr Martin
founds his most ingenious, than

of Animal Heat

useful Practice. but allowing ye Diver-
sity, w:ch ye Gentlemen mentions
to be equal & proportionable to the Di-
minution of Velocity in ye small Vessels,
yet this System may be otherwise
by the following Observations alone
viz: That in Vessels of ye same size
near the Heart, and in ye remote Ex-
tremities, the Blood moves w:h very
different Velocities, the Motion of ye Blood
in the Lungs being to ye: of ye Aorta
System as 5 to 1 nearly; & this in
different parts of the Body y Heat

Animal Heat

may vary, yet upon y^e Whole from y^e
Quickness of Circulation it will be found
nearly equal. Some other Cause must
therefore be invented to ascertain y^e
Heat.

Dr Rob^t Douglass Says y^t it is
only produced in its passage thro y^e
Capillary Vessels, or such as will
only admit one Globule to pass at one
— Ag^t this many Objections may be
brought. He thinks that in such a
Case the Vessel & Globule would act
on each other as Solids: But he does

of Animal Heat

not properly distinguish Friction from Adhesion. both the Bodies being smooth when applied may have considerable Adhesion, but no Friction, this requiring a Roughness, consequently therefore no Heat can be produced by this means.

we may add further than y^e velocity of the moving particles, absolutely necessary to the production of Heat. is here wanted, for the Blood in their Vessels, as Dr Hales has fully proved by Experiment has an extremely languid motion.

Let us now consider y^e Hypothesis by which y^e Heat of Animals is supposed

Of Animal Heat

As depends upon the motion of the Blood
thro the Lungs. The momentum here
has been already given, by w:h: appears
that want of velocity cannot be objected
— Those who endeavour to explode the
Opinion for another Argument viz: that
Heat is greatest in Breathing Animals
whose Lungs are constantly exposed to
the cool Air in Respiration. This Reason
=ning I shall not attempt to deny alter=
=ly, tho I imagine y:e Breathing is chiefly
designed to obviate y:e Disadvantages y:
might arise from too great Heat otherwise
produced in these Animals, and as a

of Animal Heat

Proof of this I allodge that y^e^ Air w^ch^ es-
capes by Inspiration is much hotter
than that taken in by Inspiration.
Besides we have no Experiments to prove
that Heat is either generated or diminished
in the the Lungs. For Blood drawn
before or after passing thro y Lungs
is equally warm. if by any Experi-
:ments a Difference can be observed be-
:tween the heat of Venous & Arterious
Blood, it happens because y^e^ latter
flows out more quickly, & thereby loses
less Heat than the former. upon the

whole. I suspect this Theory has but very little Foundation.

Dr Bryan Robinson imagined y: Heat was occasioned by Something /perhaps he meant an Acid/ Absorbed from the Air by Animals, & mingled w: the Blood of the Lungs. I differ from him in Opinion, rather supposing that Something is rejected from, than taken into y: Lungs during Respiration.

all those Hypothesis being mention'd & the Objections to each, I shall

of Animal Heat

none of them appear satisfactory. I
shall therefore deliver a few Observations
which I do not presume to offer as un-
exceptionable, but shall submit
them to the animadversions of any
candid Inquirer. it may have its
use, at least there is no Danger in
starting such an Hypothesis, y Truth
of which is to be examined by Experim.

As Animal Heat evidently de-
pends upon, or is principally con-
nected w.th the Moving Powers of the
System; so those powers are depend.t

Animal Heat

on a Subtile Elastic Fluid or Nervous

Power, conveyed to every moving Fibre

by hollow Tubes or Nerves; & in this

Fluid, Oscillations are constantly

excited. The Existence of this Nervous Fluid

after long Disputes among Physiol

is now generally admitted. It is of

such a Nature as proves it cannot

be derived from Secretions, & from the

great Subtility & Elasticity of its Nature,

it may probably have a nearer Affinity

to the Electric Fluid. I am far from

# of Animal Heat

flourishing they are the same. for tho'
a subtile Elastic Fluid may be
Foundation of Fire, Light, Electricity
and Animal Heat; yet we must con-
-sider it as very differently modified
in each of these. I shall not pretend to
conjecture in w^h^ manner these Modifi-
-cations are performed. It is enough for
our present purpose to say y^t^ such a
Fluid is diffused thro every fibre of
the Animal Body, & that from an
Actuatary Motion continually excited

# of Animal Heat

excited in this Fluid, Animal Heat is probably derived. I do not offer this Opinion as a real Truth, nor am I prepared to answer all y^e Objections that may be made ag:^t it. I only offer it as an Hypothesis, w:^ch not being entirely void of probability may be a Subject of further Experi:-ments and Observations.

We come now to the 5:^th Means of generating Heat viz by Inf:-flammation. This is commonly

Of the Generation of Heat.

Not to be an Instance of Communication,
but improperly, because the propagated
Heat becomes greater than in y^e^ Body
whence the Inflammation began at
first, and the Heat in this last Body
is not diminished by this means. in
consequence of Inflam^n^ a new Motion
is excited, and every particle or Spark
of the inflamed Body becomes as it
were a new Centre of Oscillations in
each of which a Motion is also excited
in every Direction. in these Cases only
does the Phlogiston of y^e^ Chemists

of Inflammation

appear necessary to the Productions of

Heat. Inflammation dependeth upon

a peculiar affection of this, or upon its

being converted into Vapour. Now

Other tho so readily inflammable

may have a burning Coal plunged

into it without being inflamed. Whe-

=as if the Coal be held in the Vapour

arising from the Other, it will imedi-

=ately set it on fire, the Subtile Fluid

w/ to take an Example from a Spring

coiled up/ being then let loose. we

may now think aforesaid Safety

of Inflamation

That the Collision of two Elastic Fluids is absolutely necessary to the Inflamation of those Fluids. Phlogiston must be one, and Air is generally the other. but so far as we are capable of Judging, the Phlogiston being any other Fluid will act w: it do as to produce Inflam: -mation. for Example water converted into Vapour will answer this purpose. - The Action of the Air I shall consider more fully hereafter. Bodies may be inflamed by the Action of the Air

of Inflamation

without immediate application of burning
Fewel. This appears evidently in
Sulphur if violently heated, or in Oils,
but more especially in y^e^ burning
Phosphori.

Certain Bodies are liable to, and
others incapable of Inflammation. Therefore it must require a peculiar mat=
=ter. Here a Question arises whether
Inflamation depends upon Bodies
as Exists, or whether it is essential to
some Elementary Bodies? I rather
favour the former Supposition, be=
=cause

# of Inflammation

we know of: in every Inflam^{n}: an Acid
is present, w^{ch} is not inflammable as
Oil. Sulphur. Alchohol &c. There must
then be Some other matter requisite.
this the Chemists call Phlogiston, and
they imagin it is an Elementary Matter
of itself Inflammable. Tho' however
I differ from them, for the Acid seems
to have as great a Share in the
Inflam^{n}: as the Phlogiston. this Phlo:
giston them of the Chemists I conclude to
be the Nephritic Air, which we find arises
from all inflamed Bodies, & enters

of Inflammation

sometimes into their Composition,
as in the Vinous Fermentation. In-
=flamation seems to consist in
the Resolution of this Compound in
the Air; may be necessary is that
the Air; may be necessary is that
every individual particle must ver-
=pass thereto. on this principle alone
can we acct for the Effects of y^e Blow-
=pipe. Common Air therefore is
Absolutely necessary to Inflammation,
that is for the Resolution of Phlogiston
which it does chiefly by Attracting-

# of Inflammation

vneting w^th and destroying y^e Pecu-
liar properties of its Mephitic Air. This
Mixture however like all Others is limited:
and w^ch ever more is added of either will
be kept in Solution, & consequently will
not loose its peculiar Properties. hence
it is evident if any means can be inv-
vented for Attracting y^e Mephitic
Air more strongly than y^e Surround-
Atmosphere, a less Quantity of common
Air would Suffice, by the Assistance of
such Means for a given length of time,
for the purposes of Respiration & Inflam:

Of Inflammation

This means was invented by D.r Hales.
he found that y.e same quantity of Air
which served an Animal to breath for
two minutes, would serve y.e same Ani=
=mal eight or ten minutes by y.e Interpo=
=sition of Cloths dipped in Caustic fixt
Alkali, w.ch has a very strong attraction
to fixt Air.

Phlogiston therefore is a Miat com=
=posed of Mephitic Air, and an Acid, w.ch
by Inflammable, is resolved or decompo=
=sed. it acts chiefly by means of the
common Air which absorbs y.e fixt Air.

of Inflamation

For if this was not the Case we shou'd see the Effects of Mephitic Air either inest: ting wishing Flame, or destroying Animal Life.

Inflam^{n}: is universally situated in the Vapour of Bodies. E.g: if a Candle be extinguished, & brot near to a burning Body, the Flame will be again renewed, tho the Bodies be kept at some Distance from each other. Hence also is the Exp^{t}: applicable: we lately cited, of plunging a burning Coal

Of Inflamation

into Ether. on these principles are
founded the Machines for extinguish:
=ing Fires — they contain a small
Cask of Gunn: powder w: is agains:
=closed in a Cask of water. when the
powder explodes, the force of it blows
out the Flame, & at the same time
: pierces the water w: prevents y fire from
being immediately rekindled. Lemm w:
has been said it appears that y Subject
of Inflammation is a Vapour arising

# of Inflamation

from certain Bodies; that the Vapour
must be raised before Inflammation
can take place — that this Vapour
is the Phlogiston of the Chemists com-
bined of an Acid & Metallic Air. — y.
Inflam^{n}: consists in the Resolution of
this Phlogiston, & the Absorption of y^{r}
Metallic Air by y^{e} surrounding At-
mosphere; and whereas we may
conclude y^{t} Inflam^{n}: is an Instance of
the Generation of Heat by Combination or
Mixture. that the Inflammable Gene

of Inflamation

mentioned is a part of the Phlogiston
appear from its Effects. The Acid is
not so very obvious: yet it may be
demonstrated in some Cases. Particu-
=larly of the burning Phosphori w^ch have
all an Acid for their Basis.

This is all which necessary to be said
upon y^e Subject of Heat generated by In=
=flamation. Something however
still remains to be said concerning the
production of Light, w^ch may be consi=
=dered as a different Modification of the

# of Light

same matter that produces Heat, &
indeed is has such a near affinity to it,
that they may both be comprehended
under the Term Fire. I shall not deli-
ver more upon the Subject than an
Enumeration of its several Divisions.

To the 1st Division we may reduce such
Bodies as become luminous by being
exposed to the Light of Others. Such after
being in the Light a few minutes will
afterwards dispense Light themselves for
several hours. in Accounting for this

# of Light

Some Anphoney: each Bodies Absorb
Light: but this Opinion is Open to
innumerable Objections. perhaps
Vibrations are excited in them: wch
after the exciting Cause is removed. of
this kind are many Substances in Na
= ture i.e. the Bologna Stone wch was dis
= covered by an Alchemi = philosophico
Shoemaker, & found to be nothing but a
Combination of Vitriolic Acid & Calc. Lapis
— — 2.nd a German Lawyer discovered a Phos
= phorus in dissolving Chalk in Nitrous
Acid.

and afterwards calcining it. this from
the Inventor was called Phosphores of
Bolozin. all kinds of precious Stones
particularly the Diamond exhibit
this Phaenomenon in a greater or
lesser Degree. —
The 2:nd Division to be considered com-
prehends the luminous Animals. as
Glow worms. - Moths - Insects in Sea wa-
ter &c.
Under the 3:d Division may be reckoned
the production of Light by Putrefaction as
in Fish, wood &c. but this perhaps will

be found to depend upon Insects.

Under the 2d. Division we may reckon
the Production of Light from Electricity, a
Subject so difficult and Obscure y: the
greatest Geniuses of the Age have not
been able to investigate it clearly.

The 5th. Division comprehends the
Light produced by Mercury in Vacuo.
This perhaps is only a Species of the
Electric Light. I must Observe that this
Experiment will not succeed if y: Vacuum
is very perfect.

I do not choose to enter further upon

Of Light

This Subject of the Production of Light.
I only point it But for your future
Inquiries. Nor Shall I here discuss whe-
ther Light is a peculiar Matter issuing
from the luminous Body, or only a par-
ticular Modification of the Ether: y:
is so generally diffused thro nature,
but I shall hasten to y: next part of
Our Work After concluding from w:
has been said, that Heat consisting y:
motion of a particular Matter w: is
present in all Bodies, but does not form

of the Communication of Heat

& part of Thir Phaſo as Fluids.

This part of our Subject tho' y^e
most interesting & most connected w^th
practice has hitherto been carelessly
=vated. in treating upon it I shall
endeavour to lay down a general
Enumeration of the different Laws which
& the place in y^e Communication of
Heat, sometimes adding a few
Remarks.

Law 1: The Communication of Heat
is common to all Bodies, & all Bodies

Of the Communication of Heat

will impart & receive Heat from all
Other Bodies: and this Communication
of Heat will continue 'till all surround-
=ding Bodies attain the same Degree of
Heat.

Remark. This shows $\frac{e}{q}$: expansive pow-
=er of Fire, $\frac{ch}{w}$: is always endeavouring
to recede from its Center. $\frac{e}{q}$: Action of $\frac{e}{q}$:
Sun is the most general Source of Heat
from whence Supplies are derived for
the Loss of that which is constantly flying
off. That every Where exerts a repulsive
& expansive Power, without Shewing

Of the Communication of Heat.

Any Tendency to be attracted by particular Bodies. Is a Consequence of the Equality of Heat in all Bodies itself: For as Heat is common to all Bodies, but peculiar to None; & that if in different Bodies different Degrees of Heat be observed, this Variety is owing to the Difference of Vibrations excited in such Bodies.

II.nd — The Communication of Heat between two Bodies requires some time, & diff.t times are required

of the Communication of Heat

in different Bodies.

III: The Quantity of Heat lost or received in a given time is directly as the Quantity of Heat in the communicating, & inversely as the Quantity in the receiving Body. Thus, if a Body heated to 30° be applied to one Body at 100°: & another at 200°: the heat lost or received will be greatest in the last case. Again if the Body at thirty be raised to 60°: the heat communicated in a given time will be greater when it is at 30°: than at 60°: & vice versa. —

of the Communication of Heat

Law IV: The Bulk of the Body, and the Quantity & Quality of ye Matter being given, the Heat lost or received will be proportionable to ye Surface.

— Hence it follows that ye Figure of Bodies has considerable weight in them Cases. E.G. a given Quantity of Matter will communicate or receive more Heat in the Form of a Cube than if it be moulded into ye Form of a Sphere.

V.— The Figure, Quality & Quantity

of the Communication of Heat

of Bodies being given, the Heat lost or received will be somewhat proportional to their Bulks.

Remark. If we suppose an Iron Ball to consist of a number of concentric Layers, Heat communicated to it will will pass slower, & slower from one Layer to another towards y^e^ Center. Whereas in returning from y^e^ Center Again to the Circumference of y^e^ Ball its motion will be performed in a less time, as it passes from one Layer to the greater which surround it.

Of the Communication of Heat

Law VI. Heat passes out of any Body
in y^e^ greatest proportion at y^e^ part
where the Layers are fewest.

— VII. The Surfaces & Bulk of Bodies
being given, they lose or receive Heat
in proportion to the particular Densi:
: ties of their Matter.

Remark. Muschenbroeck supposes
y: this depends upon the Density of y^e^ Bodies,
& has constructed a Table on this Suppos:
: tion. But here y: great Philosopher
certainly Mistaken: for Mercury which

of the Communication of Heat

is a Body remarkably dense grows hot
and hot much sooner than water. to
w: When ought we attribute it? — It
depends perhaps upon some parti=
=cular Quality not yet investigated
or explained. Those Facts leads us
to Observe that there are Conductors
of Heat, and non=Conductor of it as
well as of Electricity, tho not so absolute
in the former as in the latter case.
But sufficient Examinations have
not been made to determine the

Of y^e Communication of Heat

Qualities of those, or their exact Effects.

It may be even made a Query Whe-

-ther Air or water grow hot or cold soo-

-ner? I imagin however y^t y^e latter

receives Heat most readily, because

a heated Body cools sooner in water

than in Air. It is observed y^t all

Fluids & Metals are quick Conductors

of Heat, as well as of Electricity. Wood

conducts Heat very slowly. hence y^e Use of

Wooden Handles to Instruments y^t

are often applied to the Fire. —

of the Communication of Heat

If there is any Absolute Non-Conductor of Heat, it is Air; for I think it is doubtful whether Heat is conveyed thro' the Air, otherwise than by y^e heterogeneous particles y^t are always diffused therein.

Another Analogy between y^e Heat & Electricity is Wool. This Substance does not convey Electric Matter, & conveys Heat or Cold but very slowly. Hence its use in Lamp Furnaces to confine the Heat, & hence its use in Cloathing.

& hence y^e Reason why metals feel

Of the Communication of Heat

coolest to us than wood tho' both be in the same Temperature may be discovered viz: that the former convey the Heat from our Bodies much quicker that the latter.

When Bodies receive Heat on their Surface, faster than they communicate it thro their Substance an accumulation may occur greater than $\frac{a}{y}$: Heat of the communicating Body; than $\frac{a}{y}$ small wick of a Lamp may very considerably heat a large vessel. This Accumulation however is limited: for when the Heat

of the Communication of Heat

flying off from y Surface of y receiving
Body, is equal to that received from the
received from the communicating
Body, any further Increase of Heat ceases.
Bodies cool faster in y Air than they
otherwise would do, because there is
a continual Change of Air on their
Surface, occasioned by the Rarefaction of
the Air contiguous to, & the greater Density
of that at some Distance from y burning
Body. we may therefore conclude y:
Air is no more a Conductor of Heat than
of Electric Ether. Water collected in

of the Communication of Heat

Large Masses preserves nearly y^e same

Temperature in very great Changes of

the Air. and this also chiefly depends

upon the Force of Gravity, for when the

water on the Sun Sabe comes condensed

by the Cold it sinks & is succeeded by

a warmer portion: this being acted upon

by the Cold sinks likewise, while warmer

water Again succeeds place. by this

means it happens y^t some of our very

deep Lakes elude as it were y greatest

freezing power we ever Subject to this Climate.

43 *of the Communication of Heat*

In the Earth & Ocean likewise $\frac{e}{y}$ the Temperature is nearly $\frac{e}{y}$: same in all Climates & in all Seasons if we go to a certain Depth below the Surface. to determine therefore the Heat or Cold that prevail in any part of the Earth, we must not only consider $\frac{e}{y}$: Latitude of the place; but also the Distance of it from the Earths Center & from the Sea Shore. Summers as they are moister, are always colder. Winters as they are moister are always warmer. In not this owing to $\frac{e}{y}$ Disposition of moist Bodies to preserve their Temperature. —

Of the Effects of Heat

I shall endeavour to pursue this & the
following Stages beginning w: Expan-
=sion.

Expansion of Bodies is demonstrable
in the Lowest Degree of Heat w: we
are acquainted: for we cannot ex-
=amin any Body in its utmost State
of Condensation; therefore all Bodies
are liable to Expansion. Bodies ½:
are homogenious & of ½: same Struc-
=ture are expanded every way equally
by the power of Fire. Fluids generally
suffer a greater Expansion from a

of Expansion

given Degree of Heat than Solids.

This Expansion is visible in many
Fluids, and upon this depends the Con=
=struction of very useful Instruments
called Thermometers.

As the proper Application of these
is often extremely useful in Medicine,
as well as in all the Branches of Ex=
=perimental Philosophy. I think it
will not be improper to enter into
a full Discussion of them, endeavou=
=ring at the same time to point out the

# of Thermometers

Fallacies & Inaccuracy y^r may occur
in Theirise or Structure.

of the Construction of Thermometers

For this purpose we choose Bodies
that are most readily affected. or (as
I shall use the Expression hereafter) most
sensible of Heat. Such Bodies as we
have said before are Fluids. There is
one Disadvantage attending y^e use
of them, namely that they will
only measure Heat to a certain
Degree, before they are converted

# of Thermometers.

into Vapour. This Difficulty however is
pretty well obviated by the Calculation
of Sir Isaac Newton proposed.

The Fluids most generally employd
are Air, Alkohol, & Mercury.

Air has several Advantages as
being very sensible of Heat and very
expansive. But its Expansibility
is so great, that it almost impossible
to have a Scale
w: any Convenience long enough for measuring y Changes
that occur in the Atmosphere.

of Thermometers.

It is also liable to be affected by the
Variation of Density in y^{e} Atmosphere.
from w^{ch} has been said therefore it
appears y^{t} Air-Thermometers are
only fit for transitory Experiments,
and for such perhaps it is better
adapted than any Thermometers
yet invented.

Alchohol. When used for Thermometers is
tinctured wth Cochineal. that its motion
in the Tube may be rendered more Ob-
-servable. It is very sensible of Heat,
& very exhaustible, nor will it freeze

of Thermometers

but in a great Degree of Cold, yet it will not shew great Degrees of Heat because its boiling point is considerably less than that of water. upon $\frac{2}{9}$ whole however it may be employed w: great advantage in many Experiments especially since it will not change by keeping for a very great number of years. —

Bil has Often been used w: tollerable Success for shewing the Change of Temperature in the Air. For this purpose the expected Bils of Vegitables are

of Thermometers

most suitable. Oil boils only in an intense Heat, nor will it freeze but in a great Degree of Cold. but Water in a moderate Degree of Cold gives it such Fluidity as renders it entirely useless.

Mercury has more Advantages to recommend its use than any other fluid. — It is next to Air in Sensibility. it resists freezing more than any Fluid. it does not boil except in a very considerable Heat, but on the contrary

of Thermometer

it is not very expansible, so that it will not require a very large Scale. and consequently will not shew accurately the small Changes of Temperature. It is liable to be rarefied into a black powder by its motion ag: the Sides of the Tube; it will calcine before it arrives at its boiling point, thereby fouling and stopping up the Tube. upon the whole it appears that a Mercurial Thermometer is the best to be used

# of Thermometers

as a Standard. for shewing the Changes
of the Atmosphere & for great Degrees
of Cold, but should never be used for
determining Heat greater than that
of boiling Water. —

The larger the Bulb of a Thermometer
be in proportion to its Stem, & greater
will the Scale be. & the Expansions
more evident: but then as y^e Bulb be-
comes larger, its Sensibility becomes
less. the Glass of w^ch the Bulb is com-
posed should be blown as thin as is
consistent w^th its Safety. It would

# of Thermometers

also be better to make it in y^e^ form of
an Oblong or Oblate Spheroid, than in
the form of a perfect Globe. Since by
this means more of the Surface of
the contained Fluid will be exposed
to the action of Heat or Cold, & conse-
quently by Law 4.th more Heat or Cold
will be received, that is y^e^ Sensibility
will be encreased.

On the Uniformity of y^e^ Cylindrical
Tube depends in a good measure the
perfection & Accuracy of the Instrument.

When the Fluid is put into y^e^ Tube,
it ought to be as free as possible from

of Thermometers

Air, but any of the Air Separating should divide the Fluid in y^e Scale.

When the Tube is filled to a proper Height, we are generally directed to extract the Air, & then Seal the Tube Hermetically; but Mr. Wilson an ingenious Gentleman at Glasgow who makes y^e most perfect Mercurial Thermometers, says y^t the Air tho' left in the Tube does not sensibly counteract the Expansion of the contained Fluid, and y^t the

of Thermometers

weight of the Air does not sensibly affect the motion of the Fluid in the Tube.

of the Graduation of Thermometers

a Scale divided into any Number of equal parts may be applied to the Tube: but Unless in this Case some general Rule is to be followed, we cannot compare the Observations of Others w Our Own. two Standard points have therefore been fixed on, w: are the Degrees of Heat in boiling and

Of the Graduation of Thermometers

freezing water. The most easy and exact method of getting the freezing point is to put the Thermometer into melting Ice or Snow; for tho' y^e^ water may seem to be above y^e^ freezing point, yet as long as the Snow or Ice is dissolv^g^, so long is the water at the freezing point, & according ly the liquor in the Tube depres-
-sed to that point. —

The boiling point of water determined at a middle State of y^e^ Atmos-
-phere, when the Mercury in y^e^ Barometer stand at Inches 29,5; for when y^e^ weight of the Atmosphere is less, there is less

of the Graduation of Thermometers

Pressure on the boiling water, & y Liquor in the Tube will not rise to 212.° which is the boiling point on Farenheits Scale & vice versa. —

The Application

When we desire to ascertain very exactly the Degree of Heat or Cold in any Body, care must be taken to ablly the Thermometer for some time: all possible Heat may be communicated from the Body. Otherwise we shall be often deceived. as for Instance, it has long been a Desideratum to

Of the Application of Thermometers

determine the exact Degree of Heat in a healthy human Body. Fauenheit has marked it at 95: Celsius at 98: and an ingenious French Philosopher has lately informed us it should be computed at 100: or upwards. —

of Fluidity

Having said enó on the Subject of Ex=
=pansion. I shall proceed to consider
the next Effect of Fire viz Fluidity.
most solid Bodies in a certain Degree of
Heat become fluid. most fluid Bodies
in a certain Degree of Cold become
solid. if therefore any Exceptions occur
to these general propositions we must
conclude that it is owing to our Defici=
=ency in applying a sufficient Degree
of Heat or Cold. the only Fluid y: we
cannot render solid by Cold is Air, wch
altho it resists the greatest Cold we can
employ when alone; yet in Combination

it may be easily rendered solid.

Solidity & Fluidity do not depend upon the form of the physical Elements of Bodies, as some have imagined, but on y^e State of Heat in different Bodies; and therefore as the Form of Heat or Fire consists in Motion, so the Solidity or Fluidity of Bodies depends upon Rest or Motion.

I am conscious that many Objections may be opposed to this Doctrine by those who imagine that Fluidity depends on a certain Globular Figure of the ultimate particles of Bodies, w^ch enables them to roll easy over each other

of Fluidity

on the least Impulse, & that on the
contrary the particles of Solids are spiked
and angular. They suppose likewise
that the freezing of water &c: is the
most common Instance of the
Conversion of a Fluid into a Solid.
depends upon some Saline or frigo-
rific particles, which enter the
water and entangle its Globules.
The Arguments in favour of this
Hypothesis are fully drawn up by Mr:
Musschenbroek, & I shall here enu-
merate & endeavour to obviate each by

of Fluidity

my own Observations. —

I. It is said that water converted into Ice is expanded, this supposed cannot be the Effect of Fire but of some new Matter introduced.

Answer. Water converted into Ice yields a Quantity of Air, which it contained in its fluid State, & this being in some Measure involved therein, as appears from the Bubbles in any piece of Ice, renders it lighter, & at the same time expands it. as

of Fluidity

a further Illustration of this we may
Observe that water congealed after its
Air has been expanded by an Air pump
is less expanded, & its Specific Gravity
greater than usual. -

II. It is said y: water may be observed
to freeze at the Side first where y: frigorific
particles enter; Say Musschenbroek
says y: he has seen them enter in a kind
of Stream at y: part of the Phial where
the Freezing began.

Answer. The Freezing beginning
at a certain part of the Phial may

Of Fluidity

&

depend upon y^e same principles as

Crystallization, namely y^t is begun

where the Phial is thinnest or where

the greatest Degree of Cold is applied.

as to the frigorific particles w^ch this

ingenious Philosopher believes he saw

entering into y^e part of y^e Phial where

the Freezing began. I have no Idea

how they could be visible to his Eyes, &

at the same time I shall ens to pass to

pass thro the pores of Glass. I rather

suppose that what he saw was Air

seperated at the place where the Freezing

began.

III. It is said that water is longer fluid in close than in open vessels, & still longer in vacuo, because they say they the frigorific particles cannot so readily have access to the water.

Answer. Freezing water not only requires a certain Degree of Cold, but also an Opportunity to discharge its Air, w it can= =not do well in vacuo or close vessels, be= =cause there it has not common Air to dissolve the Nitrous Air evolved during the Freezing of the water.

I shall here mention a curious Exp:

of Fluidity

That occurs to my Memory of w^ch I never
have had a satisfactory Acc^t. If water
be put into a Phial covered w^th a loose
Bladder tied close to the Neck, it will not
congeal in a greater Degree of Cold than
the freezing point; but if the Bladder
be pressed down by your hand, it is
immediately converted into Ice if the
freezing Cold prevails in y^e Air.

IV. It is said that water remains
fluid when the Temperature of the Air is
below 32°: and congeals often when it is
above that point.

Answer. This Fact so contrary to general
Experience cannot be admitted, since the
Experiments have not been made by such
by attended to the Fallacies to which Ther:
=mometers are liable. - for using them
in Chambers - from their being in con=
=tact w: large Bodies y: are not suddenly
altered in their Temperature such as the
Walls of a House, & lastly from not Ob=
=serving the Interval of time between the
Effect produced, & the Examination of the
Instrument. Before this Arg: can be
be established we must find y: how to a

of Fluidity

Thermometer plunged into a water in its fluid State sinks below 32°. and y° when congealed the Therm°. rises above 32°. — Mr Musschenbroek does not pretend to have made these Experiments himself.

V. — The Appearance of Frost & Snow Sh°. be very uniform; yet in places so near each other at no Alteration of Temperature can be supposed, Frost & Snow are in some of them as in a State of Frost, in other un=dergoing a Thaw. —

Answer. Still here it has not observed whether the places where y°. different Effects were produced were also of y° same Tempera=ture

Fluidity.

Moisture retains Warmth more than
dry Air. Hence at the Sea Side no Frost is
often Observable, when at a little Distance
its Effects are very apparent. But in
those Cases I have always found a Diff.
=rence of Temperature by the Thermometer.
This may arise from various Circumen=
=stances. Besides the mere Temperature
of the Air other Causes concur for the
congealing of water, the chief of which
are the Vapours arising from the Earth.
in all Cases where this Vapour is intercep=
=ted, the Snow continues longer than usual
even in Dunghills where a greater Degree of

of Fluidity

generally perceived. Dr. Hales on Survey-
-ing a Field found only one particular
part of it covered w: Snow below which he
also found a Stone Conduit. I have
regularly observed the Truth of this Ob-
-servation, that wherever I observe Snow
melt sooner than usual I conclude there
is a lax superious Soil; — in places where
it remains longer, I conclude the Soil is
hard and rocky. —

VI. In this Argument Mr Musschenbroek
adduces an Experiment w: has been
reckoned decisive. if water in a Vessel
be put into Another containing Snow, &

of Liquidity

both applied to the fire, the snow in the external vessel will be melted, the water in the inner will be congealed. The frigo-rific particles are therefore driven from the snow to the water.

Answer. To this we need only reply: The Solution of Snow like other Solutions generates a considerable degree of Cold, which is not so much diminished for a short space of time, as not to be capable of congealing the water in the inner vessel. Provided it is near the freezing point. —

VII. It has been said that Salt put

round a Vessel occasioned a Congelation
by transmitting their Saline particles:
but this Supposition is Overthrown by con-
sidering that many Salts produce heat
from a Combination w:th water, and
that they always impede the Effects of
Cold, & render the Water more tenacious
of Fluidity. —

VIII. Again, it is said y:t Cold is more
frequent, and intense in Places where y:e
Earth is most impregnated w:th Saline Particles
— and Instance is adduced from Towerfort
who found a greater Degree of Heat
at Paris than at Armenia. But

Of Fluidity

These Observations prove Evidently y^t^ Cold is not in proportion to the Latitude of the Place. There are many Circumstances y^t^ may have an Influence on different Climates i^n^ the Elevation of the Place Above the Level of the Sea, & have found by Trial y^t^ we may Measure the Heights of Mountains as well w^th^ a Thermometer as w^th^ a Barometer. there are certain Heights at w^ch^ Freezing always takes place, & at any Place of y^e^ Elevation Snow always remains unmelted. M^r^ Gruquet has drawn a Line of Congelation & shown its gradual Descent to y^e^ Earth,

of Liquidity

ch
w: is very useful in this view. 2nd Elevation
& Latitude being given the Cold is
greater in proportion to the Distance
of the Sea. hence Lemonfort observed a
greater Degree of Cold in Armenia 4:
at Paris. Edinburgh & Petersburgh
are nearly in the same Latitudes, yet 4:
Latter is further from the Sea, & accordingly
we find a great Difference of Temperature.

IX It is alledged that Snow melted differs
from pure Fountain water. Blaus
Borrichius found 4: the former Latter would not
answer all the purposes of the former
Latter. There is no occasion to refer this
Difference to frigorific particles. The

of Liquidity

aenate Magreaf has found y: y melted
Snow is harder. But as there is a Differenc
between boiled & Spring water from y: latii:
=cation of Air from the former so in the
same manner may there be a Differenc
between melted Snow & water, as the
latter may be Sometime in absorbing its
proper Quantity of Air w: encreases its
power as a Menstruum.

X. - The Inhabitants of the Alps from
using melted Snow are liable to a Disease
called Gutter tumiduem.

Answer. all the Inhabitants who
drink melted Snow are not Afflicted w: the

of Fluidity

Disorder. nor is it observed in other Mountains as the Andes in America Where Snow water is used as freely as on the Alps.

XI. It is said y Ice does not encrease in thickness according to the Cold; this reason must be owing to y Inclusion of Frigorific particles by the Ice already formed.

Answer. the Ice resists considerably y Communication of Heat. the water likewise being enclosed by the Ice it self is unable to cool it self with fixed Air.

XII. It is said we frequently observe

of Fluidity.

Ice on water during the night, & yet a
little after Sun-Rise the Sun-Sun will
be covered with a thin Crust of Ice. the
Cold during the night was not therefore
sufficient for this purpose, but in the
morning the frigorific particles were
brot into the Atmosphere, & a congeala-
tion immediately produced. —

Answer. I have often observed this Phe-
nomenon. I agree w: Dr Franklin: y:
the Cold during the night was not duly:
to produce the Effect, Yet it was so near
the freezing point than when y Sun

of Fluidity

Above, and Evaporation begun to
commence, a greater Degree of Cold
was produced, & in Consequence of it a
Congelation.

XIII. The Effects of Air upon Ice are
not the same as upon water. This must
therefore be owing to some extraneous
matters.

Answer. In innumerable Instances
we find that y^e Difference of Aggregation
causes a Difference in the properties of Bo-
-dies without the Admixture of any new
matter. From considering therefore the
Discussion of those Arguments you will

of Fluidity

Lega to see the Truth of w: we alledged, that the
Freezing & Congelation depend upon a
certain Degree of Cold, & y: there is no
Foundation for thinking they are con-
-nected w: any Frigorific Particles.

There are some Special Phanomena w:
Regard to the freezing of water w: have given
Occasion to this Dispute. Thus in some
Bodies the Change from a Solid to a
fluid State is by gradual & all possible
intermediate Degrees, without our being
able to assign the exact period of Fluidity
& Firmness: Water on y contrary passes
from the one State to the other in a Moment.

of Fluidity

Wax is given as an Example of the former Change. There are however very few Bodies that do not connete at a certain time. it has been imagin'd by some y^e^ the Concretion of Metals is analogous to y^e^ of Wax. but Reau: =mear= has shewn y^e^ it is more analogous to water; and in y^e^ of wine & several oily Bodies the Concretion is as sudden as that of water. the Cause seems to be this. There is always in water a certain proportion of Air at a certain Degree of heat in a fixed State. if the heat is diminished the power of the water to

of Fluidity

a pressure is diminished, & so a
quantity of the Air is set free. ℣ Fluidity
of the water seems to depend in a great
measure upon the presence of fixed Air, so
that as soon as it is extricated by a sensible
Deminution of that the water becomes
solid.

The same thing happens to all other
Bodies liable to a sudden Concretion. ℣
French Academicians who went to Lap-
-land found the Spirit in their Thermometers
suddenly frozen & raised higher than before
it expanded by the fixed Air extricated &
restored to a fixed State. Beaumeur found

of Fluidity

also in Metals. as for Example: Iron
that they also expanded aty^e Instance of
Concretion: owing to the Elasticity or
to the extricated Fluid as before. —

You see then the great probability
Fluidity depends upon that. Why this
Cause operates so unequally depends upon
peculiar properties in Bodies which have
hitherto been unexamined & unexplain-
=ed. —

# of Vapour

The third general Effect of Heat is the Conversion of Bodies into Vapour.

The Evaporation of Bodies may be considered as of two kinds 1st: The Solution of different Bodies in a State of Vapour 2d: The Conversion of Bodies to Vapour where every particle repells another, and becomes as it were the Centre of an Elastic Atmosphere. —

The Solution of Bodies in Vapour seems to be the Cause of several Phaenomena, particularly the Ascent of Water of Water from the Earth in a State of

Of Vapour

Vapour, w^ch certainly for the most part depends on Solution. Nothing is more certain than that water Absorbs Air and fixes it, & Again that Air carries off Water, & volatilises it. But Air like Other Menstrua acts in the Solution of Water according to its Density. Heat & Density. Gravity. And if this is true y^e Laborious Hypothesis of Desaguliers & Others must fall to the Ground. The Hypothesis is very plain, & exactly consistent w^th all the Phaenomena.

The Ascent of Water in to the Air when boiling is owing to Heat, in all Other

cases it is owing to Solution.

The Conversion of Bodies into repellent
Vapour takes place both in Vacuo & in
the Open Air. After this begins to rise
copiously no further Degree of Heat can be
produced in the Liquor or other matter.
This Conversion of Bodies into Vapour at
a certain Degree of Heat occurs in all Bo-
-dies.

Besides Fluids a boiling point is observed
in many Solid Bodies reduced to a fluid
Form. Of the metal: Class. Those are
in
none but Gold & Silver w: cannot be
brot to the point of Evaporation in Chemi
-cal

of vapour

Furnace; & even then in y Focus of

of a burning Glass have been convert-

-ed into vapour. if some Earths are

capable of resisting this Heat, it may

be fairly attributed to the Defect of Vio-

-lence in the Heat w^ch we can apply, &

Hence follows our Proposition will remain

"that in all Bodies a boiling point oc-

-curs w^th all its Circumstances".

The Phænomena w^ch occur generally

in boiling are i.^o that when Water receives

a Quantity of Heat it is expanded without

losing its Transparency. if after sometime

we look Obliquely into the Glass vessel

Vapour

containing the water we shall perceive
an intestine motion & Stria formed. After
this the Transparency is disturbed, but
recovered before boiling. —

When the Transparency is thus recovered
Bubbles arise from the Bottom, & either
Bubbles w: were before at the Sides rise to
the top, and dissolve. towards y^e^ boiling
point the Bubbles rise most copiously, &
at that point numerous & large Bubbles
fly up to the Surface and explode. intro-
-duce Heat the breaking of the Bubbles is
not so quickly performed. from y: moment
two a part of the liquor is dissipated in y^e^ air.

Of Vapour

Let us now endeav^r to shew: for these Phænomena. That Bubbles w^ch occurin boiling, must not be mistaken for Air or any other Fluid w^ch can be contained in Vessels. Dr: Boerhaave relates an Exp^t: from Mariotte by w^ch it appears that the Bubbles easily peirce thro Glass and escape. Pollet relates Something of the same kind w^ch he regard to Mercury. Over a Bottle of which he tied a Bladder very accurately, made the Fluid boil — and found y^t by Subtile matter exhaled as easy, as if the Bladder had not been there. from this it appears y^t

of Evaporation

It is not Air, but a Subtile matter
escaping from the burning Fuel into
the Water that occasions y Bubbles.
— all the other Phanomena may be
explained upon the same Principles.
— The Expansion necessarily ensues
on the Entry of the Elastic Fluid. in most
Fluids uniting then occurs if properly view'd
a similar Appearance of Steam from the
Motion of the One thro the other. in Con=
=sequence of further Diffusion, but not
proper Mixture, more or less Capacity
occurs, ch: afterwards disappears when
the Mixture comes more perfect. with

Ft Vapour

much the same Appearances does the
Mixture of Alchohol & water take
place. first this appear w.ch go off &
are succeded by a milky Appearance,
w.ch When the Mixture is finished become
Again transparent. —
all these Phanomena tend to show us
y.t in boiling a new matter is gradually
furnished equally dispersed thro the water.
at length a certain Quantity being intro=
=duced the water can retain no more. but
the Elastic Fluid leaping into it form those
Bubbles which Appear at the Bottom,
& w.ch in Consequence of their Elasticity &

Of Vapour

Less specific Gravity rise up to the Sup.ce so that all the Fluid y: enters the water &c= = ter the point of Ebullition flies off. this does not depend on the Nature of y: water, but is influenced by the pressure of the Air on its Surface: and according as this pressure is greater or less, the water will retain a greater or less quantity of the Elastic Fluid, & the Phaenomena of Ebullition occur sooner or later. thus by an Experim.t of M.r Montesquieu Sun.t it appears y: as we ascend higher into y: Atmosphere, water boils sooner, on the other hand in a Digester in w.ch Air is in= = cluded

Of Vapour

& w: by heat will be enabled to exert its Spring. the water may be heated without boiling. to any Degree of heat w: the Strength of the Vessel can bear.

As soon as water boils a Dissipation begins. this Dissipation as carrying away part of the mass of water, & consequently of the Fluid conjoined w: it might be supposed to cool the Liquor, but the Elastic Fluid enters in as great proportion as it is carried off by Dissipation. w: we would chiefly infer from this is, a pretty strong proof that the Solution of Lime on

of Vapour

Bodies depends on a Subtile Fluid:
=ring them, in certain Circumstances in
a greater or lesser proportion. This Fluid
=tence of such a Fluid being granted, we
can conceive how it may determine
the Aggregation of Bodies. to explain
its Effects a Postulatum must be assumed,
which indeed may be in some measure
proved Viz: if the Atoms of Bodies ap=
=proach to a certain Degree of Contiguity,
the Attractive interposed between such contigu=
=ous Atoms will act less powerfully than
that which is without them. This granted

of Vapour

we can Account for the Difference of

Aggregation.

When two Atoms approach so near

the Action of the Atom without them, overcome

that of the Atoms betwixt them. those two

Atoms will be pressed together & form a

Solid. this will be more Cohesive intro-

=portion to the closer Contiguity of the

Atoms.

The Attraction in the Expansion of a

Body will depend of the Quantity of Attra-

in a Body. when this is in such a Con-

=dition that the Action of external &

internal Atoms are in a Ballance the Body

Of Vapour

becomes fluid. if we proceed to suppose
that the internal overballance the
external Atter, then every particle is sur=
=rounded w:h an Elastic Atmosphere of ch:
It is the Center, repelling every Atter partic=
=le surrounded in the same manner Again
repelled by these. a Body then will be in
the State of Vapour.

Besides the Effects of Atter already men=
=tioned, it is probable y: by y Interposition
of the Atterial Fluid, the boiling Liquor
is never in Actual Contact w:h y Bottom
of the Vessel. this will Acc:t for w:h happens
to heterogeneous Masses exposed to boiling.

Of Vapour

Viz: That before boiling they are decom-
=pounded, & let fall a matter to the
Bottom, w^ch sticking to the vessel is
more heated than the rest of the Liquor.
but if we can prevent y^e sticking of this
matter till the boiling begins, there is
afterwards no Danger of such an Accident.
Again. formerly observed y^t in Chymicall
Operations we should never use such vessels
as are corroded by the Matters to be put
in them. it is known however that Leaden
vessels often boil Acids in them without

of Vapour

bad Effects; but they always take care
to throw them in a Out boiling, during
which time, by means of the Elastic Atten
they are prevented from touching the Vessel.
— If in any Case the boiling Liquor is of
considerable weight & viscidity, in so much
as to hinder the Ascent of the Atten, and
force it back, on the Bottom of the Vessel,
it is easy to see that acting Perp: the
Bottom & Sides very powerfully, it will
break the Vessel: hence y Precepts of
which Bottoms to Convibles. —

If One Vessel of water be put into
another Vessel of water, the water in the

Of Vapour

inner Vessel will never boil, Altho' the
Heat come up to the boiling point.
Water can receive only a certain Degree
of Heat, for after this the Other flies off as
fast as it enters. all this Other comes
from the proper Surface of the external
Vessel, and therefore w: is superfluous
Heat off thro the Water it contains,
without entering the inner Vessel. Hence
There is no Appearance of Ebullition of y:
Latter.

Tho we can explain this y Phenomena
of boiling, Yet we are no more in a Condition
to explain why it happens in different

of Vapour

Bodies at different Degrees of Heat, than we formerly were to explain under the Head of Fluidity why Heat acted with such various Effects on different Bodies. — It is probable however that it does not depend so much upon a Difference of Mixture in Bodies as on their State of Aggregation; for the Phenomena of boiling occur duly in such Bodies as are homogeneous, & suffer no Decomposition during boiling. Thus Oils have no boiling point since they are decomposed by a boiling Heat; some parts flying off & others remaining behind w: alter the

Of Vapour

State of the Liquor, & its Aggregation.

In decompounded Liquors another Difficulty occurs; for when the Vapours arising from them are condensed, they do not assume the usual Form of the Fluid, as happens in the Vapours of homogeneous Fluids. Hence Vapours may be either the constituent parts of a Mixt, or of Integrant parts of an Aggregate.

a Question properly occurs here. Why Solid Bodies are more subject to Decomposition by Evaporation than fluid Bodies? — To attempt a Solution of this we may say that Fluids do not resist the

of Vapour

Section of Fire as much as Solids, and
therefore are raised together. Whereas
Solid Bodies often require such a Heat
to fuse them as Aggregates, as is
sufficient to decompose them as Mists.
— Thus in the Calcination of Antimony
while it continues in powder, it suffers
a Decomposition, and ½ sulphureous
parts arise only. Unless on the other hand
the heat is raised to such a Degree as to
cause a Decomposition of the Metal.

Of Ignition

The Fourth, & next Effect of Heat w^ch^ we shall mention is Ignition. this is in some measure common to all Bo= =dies w^ch^ can sustain a sufficient Heat without Dissipation. Ignition is attended w^th^ a certain Degree of Light of a red Colour, tho' it differs from Inflam= =mation. the former is an Affection of the whole Mass; the latter is confined to the Surface of the vapour of Bodies. Ignition take place wherever a sufficient Heat can be applied to Bodies capable of it. thus by the help of a Lens we can ignite Bodies in water or brass. on the contrary --

# of Ignition

Inflammation cannot take place with-
-out a free accession of common air.
— Wherever Inflammation happens a
Decomposition takes place, but Ignition
is not an affection of particular Mixts.
It is common perhaps to all Bodies in
are capable of having a certain Degree
of Heat without Dissipation. we cannot
prove this from actual Experiment,
but it plain from Sir Isaac Newtons Scale
of Heat. that Ignition occurred at the
same Degree of Heat in all the Bodies he
tried. Sometimes it is attended with

of Ignition

Inflammation & Evaporation. These however are the Effects of particular causes. —

5th. Of Calcination. This Effect of Heat tho usually confined to particular Bodies, is perhaps common to all. Its Effects are to change either Fluids or Solids into a powdery friable matter. in Mercury this was long ago observed. But it is now established by Experiment 4. water & Alcohol may now be made to undergo the same change. Boyle's Exp. 3. have been confirmed by Geoffroy. &

of Calcination

Margraaf has shewed the Effects in water.
It happens in all kinds of Bodies tho'
a sufficient Degree of Heat can happen,
and which will retain it. Gold & Silver are
the only Exceptions, and there is Reason
to suspect the same of these.

It appears that most Bodies when
calcined sufficiently acquire an Increase
of weight. This does not happen from the
Fire, since the Effect appears when the
Calcination is performed in the Focus of

of Calcination

a burning Glass. Tho' we have alledged & I hope with Some Reason, that the Phanomena of Fire depend upon a Subtile Fluid, yet we must allow y^e^ it is notwithstanding full of gross Matter, as in y^e^ Case of Air, and the Electrical Fluid. we Suppose therefore y^e^ the additional weight is caused by the Intrance of the gross Matter into the calcined Subtance of the Fluid into the calcined Substance. Some suppose this to be owing to the particular Matter of Fire & M^r^ Boyle alledges it as a Proof of the Ponderability

# of Calcination

of Fire & Flame. considering y^e^ State of the Other Phanomena we cannot imagin it to be Fire itself, w^ch^ gives the weight, but rather the grosser matter adhering to it. —

6^th^ of Vitrification. In y^e^ ordinary manner in w^ch^ we see this Take place, it seems to belong to certain Matters only. Others however have maintained that it is a universal Effect of Fire. we shall not here enter into this Dispute, but only mention two Facts w^ch^ are relative to it 1^st^ That in every Case of Vitrificati= =on it is Induced by Calcination, either as

# of Vitrification

in the Case of Metals when melted &c, or in other Cases by the Addition of proper Matters. 2:ndly It is constantly attended w:th a Change of the Body from an Opake to a transparent Substance. It is always necessary to the Transparency of Bodies that they consists in thin plates. We know y:t most natural transparent Bodies are composed of such thin plates as Crystal Diamond &c, w:ch may be either seen or inferred from Experiment. in Artificial Glass it is very difficult

of Vitrification

to discover this Structure. it may how-
-ever be rendered evident by Decompo-
-sition: for if we make Glass w:th an over-
-proportion of Alkali, and apply an
Acid to it, it may be seperated into
thin plates like the Leaves of a Book.
do y:e we have Reason to conclude y:
Connection was in the same Manner.

of Inflammation. In treating of

the Latter Effects of Fire we endeavoured
to arrange them according to the Degree
of Heat they required, beginning w:th those
which required least: do y:e in this View

Of Inflammation

Inflamation might have been spoken
of more early.

We have mentioned formerly that this
is an affection of the texture of Bodies.
of all the Effects of Heat likewise, it may
be most properly considered as depending
of the particular Nature of a Body. -
Notwithstanding the great Diversity of
Inflammable Bodies, we have given
Reasons for supposing that they may
all be comprehended under y: Articles
of Oil, Sulphur & Alcohol.

This Division I found to be spo:
-ken under the Chemical History of

of Inflammation

Bodies Inflammables, I would not
however contend y: it is quite exact.
for will a Dissection of the Matter here:
-cessary here, if we can find a common
Matter on which Inflammability depends.
— The three Substances above mentioned
are extremely analogous to each other.
I believe they are all Compounds & that
Phlogiston is also a Compound Body.
an Acid enters into the Composition of
each of them without w: no Inflammable
Substance has been yet found. It w: consi=
=derable proportion it may enter into some

Inflammation

of Sum appears from the Analysis of Sulphur. From ½ constant presence of an Acid in Inflammable Bodies from the Convertibility of an Acid into an Inflammable & vice versa, we are led to conclude that an Acid is absolutely necessary to Inflammability: but as Acids by themselves are not inflammable, we conclude also ½: some other Substance must be united w^th: an Acid to produce Phlogiston, and that therefore it is a Compound. This Obscure Inquiry may probably be fixed hereafter. For we know certainly ½: it always

# of Inflamation.

arises from burning Bodies. this notion
was formerly printed but it might be
illustrated from the Composition and
Decomposition of Sulphur. at any rate
by proving that Phlogiston is a compound,
we leave no Room for supposing that
Fire is an Elementary Substance, and
take off the necessity of Attributing all the
Effects of Fire to a peculiar Principle, this
we may easily allow it in Inflammation.
— Another Circumstance in Inflammation
must be Observed viz. the necessary Con-
-currence of Air. a Question however

of Inflammation

Whether Air be a Pabulum Ignis, or
matter of Inflammation? It appears
that Air does not afford a Pabulum,
since other Elastick Fluids in wch we have
no Grounds for supposing a Pabulum,
will equally well serve the purpose. nay
Air seems rather to Abrade some matter
evolved during Inflammation, which if
not thus taken away would extinguish y.
Flame. The Breathing of Animals is
the most Analagous to this; for the
same Air is necessary to Breathing as to
Inflammation. & that wch is unproper for
the One is unproper likewise for the Other.

# of Inflammation

Hence it is probable, that the Air cures the same symptoms in both Cases.

I refer you to Dr Hales's Experiments on those Subjects of Breathing & Inflammation, for many Facts relating thereto. That the Matter exhaled from the Lungs is fixed Air appears probable from its Effects — in rendering Caustic Alkali mild — extinguishing Flame &c. —

Finis.